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CHARLES W. PRICE . . . . . PRESIDENT AND EDITOR
STEPHEN H. GODDARD . . . . . SECRETARY AND MANAGER
WM. HAND BROWNE, JR. . . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . MANAGING EDITOR

PUBLISHING OFFICE . . . . . 13-21 Park Row, New York
WESTERN OFFICE: Fisher Building, Chicago, Ill. L. W. MARSHALL, Manager
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ELECTRIC CRANES.

The electric motor has been used most satisfactorily in various systems and methods of handling material, but there are still a few classes of such work where it is used but little or not at all, although, for certain of them, it would seem to be peculiarly suitable. For transporting materials over long distances the electric railway has established itself firmly and is constantly expanding in this field. For shorter carries, particularly where the material to be handled is all of one class, that system of transportation devised by Fleming Jenkin and called telpherage is useful, and in this field the electric motor has secured a well deserved position. For still shorter carries, such as in a shop or factory or in the adjoining storage yards, the so-called traveling crane has become indispensable, and in the operation of this machine the electric motor has nearly driven other competitors from the field. For carrying materials from floor to floor of a building the vertical railway or elevator is employed, and for operating this the electric motor is the most generally used device. It is becoming more and more the standard motive power for elevators.

With so many examples of successful use in handling material, it seems strange that for the operation of cranes and derricks but little progress has been made in applying the electric motor. This condition can hardly be attributed to the electrical manufacturers, for the motors used on traveling cranes are just as well adapted for derricks. It is true there have been some notable installations of electrically operated derricks, and these cranes have always given excellent results. Wherever competitive tests have been made between them and derricks operated in other ways, the reports have always shown advantages in favor of the electric motor. But the standard motive power for derricks to-day is the semi-portable engine and boiler, and wherever a building is being erected one sees these machines still at work. That this is the case must be attributed either to ignorance on the part of builders of the advantages of the electric drive or to inertia, which is practically the same thing. It would seem that in these days almost every one who, in his work, must carry much material would be familiar with the many methods of doing this—even with those not directly useful in his own trade—and he should therefore know something about the gains to be effected by adopting the electric drive.

A few of these gains may be enumerated: a nuisance is removed by substituting a quiet, unobtrusive motor for the noisy, dirty steam equipment. The motor is more easily controlled and hence can do more rapid work, increasing the work which may be done by one derrick. The motor equipment is considerably lighter than an equivalent steam equipment and can for this reason be moved from point to point with less trouble. In every city and in nearly all towns and villages electric power can be purchased to-day. It is available at all hours, and to start the motor requires only the throwing of the controller handle. There is no delay in getting up steam. There is no bother about a fuel supply.

Probably many builders would admit these points, but would argue, on the other hand, that the electrical equipment is too expensive to operate. The expense of operation depends, of course, upon the locality, but, under favorable conditions, the electrical equipment has shown itself so much more economical than other types that it seems probable it would not be less efficient than the steam equipment, except under the most adverse conditions. For example, the Northeastern Railway Company, England, has equipped its large new docks at Middlesboro with both hydraulic and electric cranes. Advantage was taken of this to make competitive tests of the two systems, and the results showed twenty-five per cent in favor of the electric cranes, although the load-factor was only about half of that for the hydraulic cranes. With equal load-factors the saving, it was

estimated, would have been sixty per cent. In addition to this gain the electric cranes can be shifted easily from point to point and thus cover a large area. This can only be done with hydraulic cranes with considerably more difficulty.

Figures on the cost of operating electric derricks were given by Mr. G. Ritchie in a paper read recently before the Dublin section of the Institution of Electrical Engineers, of Great Britain. Mr. Ritchie compared first the ordinary two-ton builders' cranes. If operated by steam he said that the coal alone for such a crane costs about $5 a week. If driven by an electric motor the crane might be expected to raise one ton forty feet every five minutes, taking three horse-power. Such a crane requires about twelve kilowatt-hours per day, which, with power at two and one-half cents per kilowatt-hour, amounts to $2.10 per week for the power. In actual practice it was found that the power for such a crane at work in Edinburgh cost $1 per week, with current at the above price. Another comparison was made between an electrically operated crane in a builder's yard. The power for this cost $5 a week, but the crane did the work of the two steam cranes, the coal for each of which would have cost $8 and the operators $6 apiece.

Wherever a derrick is to be used in a shop of any kind where electric power is employed there is no excuse for driving the crane by anything except an electric motor; and for building work, except under the most disadvantageous conditions, the electric motor would undoubtedly be the cheapest method of operation in the end. The cost of the power might be several times that given in the tests mentioned above, still the electric crane would be the most economical. In a comparison of this kind one should always remember that the cost of power is, in general, a small item of the total expense, and there are gains made in other ways by using the electric drive which much more than offset an increase in the price of power. It is this feature of the electric drive that has brought about its general use in operating machine shops. The objection made to the motor drive at first was the cost of the installation and the cost of power, but now it is recognized that these are trifling matters compared with the great improvement in shop operation and the increased output which is secured. It is very probable that if some builder should be bold enough to try an electrically operated derrick he would thereafter never use any other kind.

AN EXPLANATION OF LUMINOSITY.

The study of the conduction of electricity through gases and work in that newer field—radioactivity—have brought about some marked changes in our ways of looking at certain physical phenomena. The ideas developed by Thomson and his school strike at our fundamental conceptions of the atom, and hence might be expected to be applicable to all phenomena attributable to atomic action. Nevertheless, one is frequently startled by the wide application which is being made of the new theories. No one is ready to accept all of these new applications, but so frequently the ideas of corpuscles and electrons offer simple and understandable explanations of phenomena hitherto unexplainable that the result is most striking.

In line with this application of the new theory was a lecture by Professor J. J. Thomson recently delivered before the Royal Institution, of London. This was an attempt to show how certain spectroscopic phenomena hitherto unexplainable might be accounted for by the corpuscular theory. According to the theory of spectroscopic analysis, every atom, when luminous, sets up definite vibrations; yet it is known that under proper conditions an element can be caused to give different spectra.

Professor Thomson's idea of luminosity is that it is not merely a vibration of the atom which begins gradually as energy is transferred to it, but that it is due to a partial breaking up of the atom. As the atoms of gas, for example, in a vacuum tube are bombarded by the charged particles conducting the current of electricity through the tube, energy is transferred to them. However, they do not begin to give out light until a certain critical point has been reached, until a certain amount of energy has been transferred to the atom, which is so great that the atom relieves the internal pressure, as it were, by throwing off a corpuscle, and, in doing so, is set into violent vibration and thus emits light. These ideas agree with the known facts of conduction of electricity through gases. The current does not seem to follow Ohm's law directly, but critical points are found where there are sudden changes. To account for the different spectra which may be given off by an element, it is necessary to assume that the atoms of this element can be caused to vibrate at different frequencies. This requires that there should be at least two critical points, which are reached under different conditions.

Thomson's idea is that such atoms have two absorbing systems, one of which can absorb, and hence radiate, energy at a greater rate than the other. This being the case, a long-continued, but slight, excitation could bring the slower radiating system of the atom to its critical point without carrying the other so far. Such an idea can only be accepted by admitting that the atom is an extremely complex body—an opinion held by Thomson. But the question arises, why, if the atoms of a so-called element are made up of two distinct systems, might not these two systems be separated? This would merely be breaking up the element into two others; in other words, the so-called element is not an element at all.

On the other hand, bodies which are built up of hundreds or thousands of smaller bodies must be inconceivably complex. They should therefore have not only a fundamental frequency, but harmonics; and if the quality of the note emitted by a stretched string can be changed by plucking it at different points, why should not different kinds of excitation set up entirely different vibrations of the complex atomic structure?

The study of light has always been one of the most fascinating branches of physics, and the applications of the corpuscular theory to explain luminous phenomena not only greatly increases the interest with which this study will be pursued, but widens enormously the field of investigation.

ELECTRICAL METHODS FOR SAVING THE WASTES.

Never before has so much attention been given to ways and means of reducing the losses in industrial works of all kinds. Not only is the operating machinery carefully studied for opportunities of saving energy, but the methods of doing work are examined so as to detect wasted time, and the cost of apparatus is compared with the savings secured through it, in order that that solution which is the cheapest in the end may be adopted. Shop methods are being systematized and more expensive machinery is being installed so as to increase the efficiency of the establishment as a whole, and thus reduce the cost of working, either by cutting down the total expense or by increasing the output for a given operating cost. Sometimes gains are made in both directions. In this important development, electrical methods are playing a large part. The power-producing part of an establishment, by adopting electric transmission, can be concentrated at one point, as it should be for the most efficient working. The electric motor not only increases the output and improves the product of individual machines, but renders possible a better arrangement of the shop. The electric light supplies the illumination necessary for the best work during the dark hours of the day, and the telephone and telegraph have wonderfully increased the efficiency of communication.

Such developments in industrial works naturally turn our attention into other fields. We see the losses going on at all water powers, and seek to turn to useful purposes power that has been going to waste for ages. Again electricity comes to our aid, enabling us to deliver, at points where it can be used, a large proportion of the power which has heretofore been lost, and which could not be employed effectively by older methods. Every year records new installations of this character throughout the different parts of the world, and capital is constantly seeking for new water powers, which offer a profitable investment for development, and which either give rise to new industries or save fuel that would otherwise be consumed. Any conservation of our fuel resources to-day is of great importance because we are unfortunately still forced to employ inefficient methods of converting them into power.

The success of the hydroelectric developments naturally turns the attention of the engineer to other possible sources of power. One of these is the waste taking place at blast furnaces. The value of the gas heretofore allowed to escape is now fully realized, and probably within a few years this source of waste will be largely eliminated. Power distribution by electrical methods offers the solution. It has already been put into practice at a good number of such establishments.

The coke industry offers another illustration of a great loss of energy, but as yet we do not seem to be able to meet the conditions existing at the coke ovens so as to make the utilization of these gases profitable. That it will be done some day can not be doubted. It may be brought about by improved apparatus or by the ever-increasing demand for power or the constantly rising price of coal.

There are other instances where large amounts of power are allowed to go to waste, either because we are not yet able to convert them into useful forms, or because the methods at present available would prove too expensive. In general, it is the latter reason which forbids the undertaking. The value of these power sources depends upon future developments.

SIMPLIFICATION OF ELECTRICAL SYSTEMS.

The large generating station of the near future will probably consist of a number of almost independent stations side by side, each arranged in the simplest manner possible, and each unit subdivided into sections, with a view to preventing an accident in one part from shutting down the entire section. The necessity for securing the greatest economy of operation and the utmost reliability at present calls for the use of many appliances, so that, on the whole, the station equipment of to-day is complicated; but the desirability of securing the greatest simplicity is now being recognized more fully, so that it is probable that a good many safety devices or fuel savers, having not very great value, or which will be but seldom used, will be eliminated. This has been the general tendency in the boiler house and the engine room of modern generating stations. On the other hand, the tendency at the switchboard seems to be toward constantly increasing complexity. While the wiring diagram may seem comparatively simple, the great number of auxiliary appliances required adds largely to the switchboard equipment and cost and increases the space necessary for housing it. This is an unfortunate feature and it is a question whether we do not sometimes go to extremes. May we not, before long, prefer to take greater risks, relying more upon the ruggedness of the system than to continue in this undesirable direction? The modern switchboard for a high-tension system contains almost as many devices as the rest of the power plant put together. Yet we are continually calling attention to the ease with which electrical apparatus is controlled and the safety of its operation.

This increasing complexity of the switchboard seems at the present time unavoidable, but that it is undesirable is evident. It is possibly the worst feature of multiple operation, as compared with series operation, for with the latter system the switchboard practically disappears, leaving only an instrument here and there and a few comparatively simple switches. This advantage of the series system is, in general, not sufficient to overcome its disadvantages, but the fact that a high-voltage series system can get along without a complicated and expensive switchboard section emphasizes the desirability of simplifying the controlling apparatus of the multiple system. It is probable that some simplification—possibly a great simplification—will be brought about eventually after we have had more experience in the handling of high voltages and large powers. Similar developments have taken place in many other lines of electrical design. The first tendency is naturally to provide additional devices for each new condition as it arises. Then we learn how to combine two or more of these devices, and finally, by improving the design of the apparatus to be protected, we are enabled to eliminate many of the auxiliary devices, leaving the main machine itself practically self-contained. It is such a development that we must hope for in the switching section of our large generating systems.

THE GERMAN ELECTRICAL INDUSTRY.[1]

THE YEAR 1905 A PERIOD OF PROSPERITY.

The practical freedom from electrical promotions which obtained in 1904, extended to 1905, which was a year of progress and considerable industrial activity in all branches owing to the large demand experienced both in Germany and abroad. Notwithstanding increases in the number of workmen and the introduction of overtime and night shifts, a scarcity of skilled workers was noticeable in the heavy departments incidental to the construction of dynamos, motors and transformers. In the cable branch also, and particularly lead cables, the degree of employment was considerable, the export market showing special signs of development.

The exports of cables to Russia and to Central and South America were considerably greater than in 1904, and Holland also became a large market for cables. The orders increased so much that the number of workmen was inadequate for the purpose of completing the cables as speedily as was necessary, and higher wages had to be paid in many cases. The principal exports in 1905 were as follows, as compared with the previous year:

	1905.	1904.
Electrical machinery	12,786 tons	12,164 tons
Accumulators	2,841 "	2,576 "
Cables	28,773 "	19,028 "
Telegraph and telephone apparatus, etc.	604 "	574 "

The shareholders in the Allgemeine Elektricitäts Gesellschaft, whose financial results for 1904-5 were briefly referred to in this journal on December 1, 1905, approved the accounts at the recent general meeting, although some of them urged the payment of a higher dividend than the rate of ten per cent, which was eventually passed. The gross profits amounted to $3,082,880 and the net profits to $2,738,665, these comparing with $2,609,675 and $2,141,650, respectively, in 1903-4. As in former years, the sum provided for depreciation—$114,950, as against $144,165 in 1903-4—is inconsiderable, as the new machinery and equipment have again been written off out of the profits, and thus the machinery and tools are completely written off in regard to the machine works, the apparatus department, the glow lamp factory and the cable works. The report of the directors states that a satisfactory increase in the turnover and orders took place in every branch, and the favorable results might have been influenced by the preparations of various industries in anticipation of the new commercial treaties, the effects of which the German electrical industry would have to reckon with. The development of steam turbines for land and marine purposes was successful, and the technical and economical preliminaries for the introduction of electric and high-speed railways appeared to be now fulfilled, although the experience now being gained would have an important bearing upon the actual adoption of electric traction. As to the ramifications of the company, the report mentioned that the organization embodied thirty-two companies with sixty-two bureaus abroad, as well as twenty-six installation bureaus and seventeen engineering departments in Germany, while twenty-nine agencies were maintained in countries outside of Europe. Owing to the import duties, the company had been compelled to take up manufacturing in Russia, and for that purpose the Russian subsidiary company increased its capital and acquired the works at Riga from the Union Electricity Company. At the date of the report the company had in its employ a total of 30,366 workpeople as compared with 27,487 at the corresponding period of the previous year. The machine works, where 7,252 persons were engaged, delivered 25,829 dynamos and 1,962 transformers of a total of 476,761 kilowatts during the year, being an increase of sixty-eight per cent in the output in kilowatts; the apparatus factory afforded employment to 6,405 persons, the turbine works to 1,568, the cable works to 5,634 and the motor-car works to 663 workers. The Nernst lamp was improved, and the simplification of the burner had allowed of a considerable reduction in the price of the lamp. All branches of industry provided the company with orders during the year, including the ironworks for driving auxiliary machinery, the coal mines, and the paper and textile trades; and considerable activity was manifested in central stations and tramways. The capital of the company is now being increased to $25,000,000.

The Siemens-Schuckert Works Company, which will be remembered as an amalgamation of the heavy electrical engineering departments of the Siemens & Halske Company and the Schuckert Company, is only responsible to these two companies, and therefore reports directly to them in regard to the business transacted each year. In these circumstances it is necessary to turn to the reports of one of the two proprietary companies for information. Taking the Schuckert Company, for instance, there is appended to the company's annual statement a separate report dealing with the Siemens-Schuckert Works for 1904-5. This report states that the working results fully realized expectations and rendered possible the distribution of satisfactory profits to the proprietors, after having made provision for depreciation to the extent of $543,400; but the amount of the profits is not disclosed in the report. During the year the large demand compelled the company to increase the working plant, and the sales organization was also extended. The orders received for generators, motors and transformers represented 421,862 kilowatts, apart from 14,000 motors of low powers. In addition to making further progress in regard to installations in mines and ironworks, the company carried out many new central stations and extensions of old works. The question of stations for long-distance transmission had led to the elaboration of new schemes. The 35,000-volt transmission plant ordered in the previous year had been set in operation with success, and fresh proposals with pressures up to 50,000 volts were partly in preparation and partly being executed. A large demand was experienced for steam turbines, and the experience gained with the Zoelly turbine had fulfilled expectations. The company was considerably interested in the conversion of the Hamburg-Altona Railway to electric traction, and the single-phase system had proved its advantages. The report briefly mentioned the labor troubles which occurred at Munich in the spring and at Berlin later in the year. The share capital stands at $22,500,000, of which $2,500,000 had not been called up during the year. The Siemens & Halske Company holds $12,512,500 of the share capital and the Schuckert Company the sum of $9,987,500. It is now proposed to call the remaining $2,500,000 in order to enable the company to deal with the numerous orders which have been received recently.

The accounts of the Siemens & Halske Company for 1904-5, which were approved without discussion at the recent general meeting, show that the company has had another satisfactory year indicating improvement over the previous twelve months. Given in one total, the gross profits amounted to $2,255,385 as compared with $1,852,500 in 1903-4. The general situation is as follows:

	1904-5.	1903-4.
Share capital	$13,625,000	$13,625,000
Loan "	7,065,000	7,150,000
Net profits	1,466,415	1,108,750
Depreciation	309,895	267,155
Dividend, per cent	9	7
Carried forward	$256,700	$280,275

It is important to note that the net

[1] The following review of the German electrical industry is taken from *The Electrical Review*, London.

profits have been arrived at after having written off the sum mentioned for depreciation. The profits realized from the company's share in the Siemens-Schuckert Works Company are not specifically enumerated. The directors' report states that the manufacturing business developed satisfactorily, and the orders received were about one-third greater than in 1903-4. The transfer of the light electrical engineering department to the new works on the Nonnendamm was completed in the spring of 1905, and the greater portion of manufacturing is now carried on there. After a reference to the development in telephone apparatus, fire alarm signals and measuring instruments, the report pointed out that a number of railways in Germany and abroad had adopted the company's switch and signaling appliances. The new Tantalum lamp, after reaching a daily production of 1,000 lamps, was brought under public notice, and both manufacture and sale had made satisfactory progress. As far as electric railways are concerned, the extension of the Berlin underground line from the Knie to the Wilhelmsplatz was to be opened in 1906, and the negotiations for a prolongation of the railway into the inner portion of Berlin seemed to be approaching a conclusion. In conjunction with the Allgemeine Elektricitäts Gesellschaft, the company had entered into an agreement with the City of Hamburg for the construction of a city and suburban railway at an estimated cost of $10,250,000, and the contract had been approved in principle by the citizens. The report mentioned the late labor troubles, which arose, it appears, for the first time in the history of the firm, and which led to the temporary closing of the works. The balance sheet shows that the company is interested in the Siemens-Schuckert Works Company to the extent of $12,500,000, in the Austrian Siemens-Schuckert Works Company for $2,250,000, and for over $2,500,000 in various subsidiary companies. It was stated at the general meeting that the works were well employed, and satisfactory results were also expected for the present financial year.

The Schuckert Company (Elektricitäts Actien Gesellschaft vorm. Schuckert and Company) has again declared a dividend, this being the first occasion of profit distribution for a period of several years. At the recent meeting certain shareholders desired to be informed of the amount of profits received from the company's investment in the Siemens-Schuckert works, but no information on the subject was placed before them. The main financial features of the Schuckert Company are given below:

	1904-5.	1903-4.
Share capital	$10,500,000	$10,500,000
Bonds	7,300,000	7,675,000
Net profits	368,110	316,865
Dividend, per cent.	4	Nil.

The surplus available for disposal becomes increased to $669,185 by reason of the balance brought forward from 1903-4, and after providing for the payment of four per cent dividend, there remains $230,730 to be carried to the next account. The directors' report states that the Siemens-Schuckert works yielded satisfactory results, and the company's other investments and participations also in the majority of cases realized larger surpluses. The company holds $7,205,000 of the share capital of the Nuremberg Continental Company, which is entered at one-half of its nominal value. At the Schuckert meeting it was suggested that the share capital of the Continental company should be reduced. The directors replied that attention had already been given to the question, but that an opportune time for the scheme to be undertaken had not yet arrived.

The Elektrische Licht und Kraft Anlagen Gesellschaft (Electric Light and Power Investment Company), of Berlin, has declared a dividend for 1904-5 at the rate of seven per cent on a share capital of $4,687,500, as contrasted with five per cent on the same amount of ordinary capital in the preceding year. According to the accounts, which show the profits in a single total, the gross revenue from shares, syndicate participations and interest reached $659,750, as compared with $481,775 in 1903-4, and the net profits were $425,520 and $305,080, respectively. The company's loan capital is $4,375,000 and the interest payments absorbed $196,875. In addition to numerous German undertakings, the company is also interested in many lighting and power enterprises in different parts of the world. A loan of $300,000 advanced to an English firm still stands in the books, and the sum of $75,000 represents the company's holding in the Underground Electric Railway Company, of London.

Treasurer's Report of the International Electrical Congress of St. Louis, 1904.

The treasurer's report of the International Electrical Congress of St. Louis, 1904, shows a balance of $2,046.37. The executive committee of the congress has decided to offer this unexpended balance to the library of the American Institute of Electrical Engineers, as a fund in perpetuity, commemorating the International Electrical Congress of St. Louis, 1904, the annual proceeds to be applied to the purchase of international electrical literature.

Annual Report of the Directors of the New York and New Jersey Telephone Company.

The annual report of the directors of the New York & New Jersey Telephone Company, for the year ended December 31, 1905, has been published.

The gross earnings were $6,217,288.18. The expenses of operation were $4,575,844.80. Interest at $62,617.58, and taxes, at $132,809.81, with dividends paid of $1,034,149.50, left a surplus for 1905, of $411,866.49, making the total surplus $3,997,828.42.

The total gain in stations was 31,725, nearly forty per cent.

At a special meeting of the stockholders held October 25, 1905, the authorized capital stock of the company was increased from $15,000,000 to $50,000,000, and on October 27, 1905, the board of directors authorized the offer to stockholders of $3,442,525 of the new stock at par, being twenty-five per cent increase upon the stock outstanding. This new stock was fully subscribed for, and its issuance brings the registered stock of the company up to $17,360,000, of which amount, $148,600 is held in the treasury.

The operations of the sinking fund, created for the reduction of the company's general mortgage bonds of 1890, has resulted in the purchase and cancellation during the year of $18,000 of these bonds, making the bonds outstanding at the close of the year $1,250,000, a total reduction of $250,000 from the original amount of this loan.

The expenditures for extension of plant and real estate during the year were as follows:

Real estate	$463,767.76
Equipment	849,490.59
Telephone lines	1,714,090.56
Making a total amount charged to construction of	$3,027,348.91

During the year the rates for service in the boroughs of Brooklyn, Queens and Richmond, the cities of Jersey City, Newark and Hoboken and other places were revised, involving a substantial reduction in the charges for many classes of service; the toll rates between various points were also revised and reduced.

New buildings have been erected in Newark, Montclair, Morristown and West Brighton, and new buildings are under way in Hoboken, Passaic, Jamaica and other smaller towns. Sites have been secured for the erection of additional buildings at Newark, Plainfield and Flushing during the coming year.

ADIRONDACK POWER.

BY ALTON D. ADAMS.

Adirondack water develops some 200,000 continuous horse-power in its descent to sea level. On the basis of a discharge during only 3,000 hours per year, this water would develop more than one-half a million horse-power.

Nearly all of this power is now expended in useless work on the beds of the streams that flow from the Adirondack mountains, but the physical geography of this region is such that the flowing water can be harnessed for purposes of industry at very moderate cost. The striking and characteristic features of the Adirondack country are its high elevation and its great reservoir capacity, which give every cubic foot of water falling there an exceptional value for power purposes. Over an area of more than 11,000 square miles the Adirondack forests, mountains and lakes have a minimum elevation of 800 feet, and this increases to a maximum height of 5,344 feet at the summit of Mount Marcy. Much the greater part of this entire area lies at elevations of 1,200 to 1,700 feet above sea level, and is a network of lakes, swamps and streams. The lakes alone cover hundreds of square miles and lie, for the most part, at elevations of 1,400 to 2,000 feet above sea level, though lake Tear of the Clouds, one of the sources of the Hudson river, is some 4,300 feet above the ocean. Lake Placid, some five miles long by one and one-half wide and 2,000 feet above tide water, represents, perhaps, the most notable combination of area and altitude. Among the larger sheets of water are Upper Saranac lake, nine miles long by one and one-half wide and with an elevation of more than 1,500 feet, Big Tupper lake, six miles long by two wide at elevation 1,500, Raquette lake, seven miles long, three wide and some 1,700 feet above the sea, and Long lake, whose greater dimension is fifteen miles, whose width is one mile and whose surface is some 1,600 feet above the Hudson river at Albany.

Out of the Adirondack region flow nearly a score of rivers, of which the more important are the Ausable, Saranac, Chateaugay, St. Regis, Raquette, Grasse, Oswegatchie, Black and the Hudson. These streams have their head waters in the lakes and bogs with which the region abounds, and some of them are the outlet of a great reservoir capacity in the lakes along their upper levels. Aside from the Hudson and its branches, substantially all of these rivers empty into lake Champlain, the St. Lawrence river, or lake Ontario, and as the elevation of Champlain is ninety-four feet, of Ontario 246 feet and of the St. Lawrence at Montreal seventeen feet above tide water, the great part of the fall of the Adirondack waters is available for power production in the state of New York. Of all the rivers that flow from the Adirondack region, the Raquette and the Hudson are the two most important for the development of useful power, though some of the others are not far behind in this respect. The prime importance of the Hudson is due to its great fall and drainage area, which latter amounts to 4,000 square miles exclusive of that of the Mohawk river, or about one-third of the Adirondack region. From lake Tear of the Clouds to Troy, a distance of 150 miles, the Hudson river drops 4,317 feet, and along the remaining 150 miles of its course to New York bay the fall is five feet. With a drainage area of only about 1,100 square miles, or ten per cent of the elevated Adirondack country, the Raquette holds second place in its importance as a power stream of the region because of the great storage capacity of its lakes, and its high percentage of runoff. Unlike the drainage area of the Hudson, that of the Raquette, lying within the Adirondack region, is in the main free from steep slopes, and consists largely of a plateau lying at an elevation of 1,200 to 1,600 feet above the sea. In this area are Little and Big Tupper lakes, Long lake, Forked lake, Raquette lake and Blue Mountain lake, 1,800 feet above sea level, all of which discharge into the Raquette river. Between these lakes are large tracts of swamp land and numerous ponds. With so much of its drainage area made up of swamp and water surface, the Raquette river has a minimum discharge rate of about 600 cubic feet per second, or 0.66 cubic foot per second per square mile of drainage area, at a point below its connecting lakes, and above which its drainage area is some 900 square miles. This minimum discharge rate occurred in August and September, 1904, at the point just named on the Raquette river. In this same August the minimum discharge of the Hudson river at Fort Edward, above which the drainage area is 2,800 square miles, was down to 1,280 cubic feet per second, or 0.45 cubic foot per second per square mile of drainage area. Comparatively little of the power of the Adirondack streams has thus far been developed for useful work. On the rivers flowing to the north and west the development of power has been particularly small, but construction now in progress along the Raquette will give it an important position as an industrial factor. The Hudson has a long lead over all other Adirondack rivers in the capacity of its hydraulic plants, but even in this case the actual is only a small part of the possible development of power for useful purposes. The largest hydraulic development on the Hudson is that at Spier Falls, where a dam gives an operating head of eighty feet of water on the wheels, and the electric station is designed for an ultimate capacity of 32,000 horse-power. At Glens Falls and Fort Edward are large water powers devoted to local manufacturing purposes, and at Mechanicsville there is another electric station from which, as from that at Spier Falls, energy is transmitted to Schenectady, Albany and Troy. In the first fifty-two miles of its course, from lake Tear of the Clouds to the mouth of North creek, at the head of railway transportation, the Hudson river falls 3,341 feet, and there is no important power plant along this part of the stream. Another stretch of sixty-eight miles, to the crest of Saratoga dam, ten miles below the Fort Edward railroad bridge, carries the river down 879 feet to elevation 102 above tidewater. Only the smaller part of this descent of 879 feet in the Hudson is devoted to any useful work, though this part of the river drives the great electric station at Spier Falls and the paper mills at Glens Falls and Fort Edward. With a total fall of 4,317 feet from lake Tear of the Clouds to Troy, probably not more than 300 feet of the descent of Hudson river water is utilized in industry, or say seven per cent. And this is the best developed of all the Adirondack streams.

Silence every steam engine in the state of New York, and Adirondack water will carry their loads, if storage is provided to conserve it, and electricity distributes its power.

The National-Interstate Telephone Association.

The following committees of the National-Interstate Telephone Association have been appointed:

"Standard Forms of Accounting"—Charles F. Bender, Pittsburg, Pa., chairman; C. J. Myers, Kansas City, Mo.; George T. Hewes, Des Moines, Iowa; R. E. Mattison, Lincoln, Neb.; H. W. Spooner, Minneapolis, Minn.

"Standardization of Equipment"—M. H. Clapp, St. Louis, Mo., chairman; W. C. Polk, Birmingham, Ala.; Edmund Land, Grand Rapids, Mich.; O. F. French, Cleveland, Ohio; J. W. Kelly, Jr., Philadelphia, Pa.

"Standard Operating Rules and Regulations"—J. B. Casey, St. Louis, Mo., chairman; W. D. Handlan, Wheeling, W. Va.; L. R. Herrick, Freeport, Ill.

New Equipment of the Paris Metropolitan System.

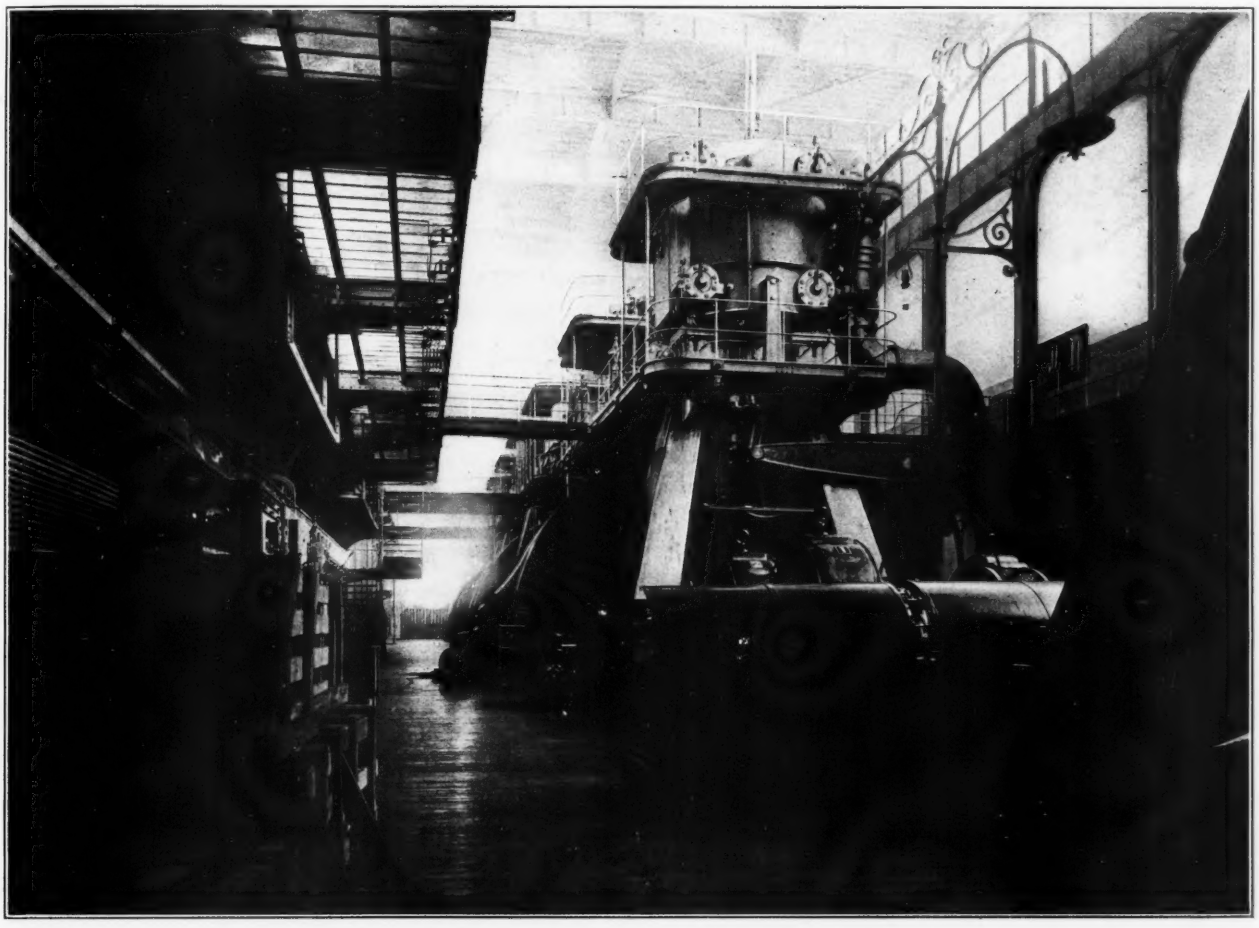
Details of the Addition to the Power-House for the Paris Subway and of the New Substations.

By B. F. Hirschauer.

THE large central station lying on the Seine, which is used for operating the Paris subway, has been more than doubled in capacity within a recent period, in order to keep pace with the extension of the subway, seeing that the new sections of road which have been lately opened up for traffic require a large amount of current. This is likely to increase in the near future, as the work is actively carried on in the other sections of the line.

Upon the opening of the subway the Metropolitan station was equipped with machines to the capacity of 6,000 kilowatts. This plant, which has already been described, consists of five batteries of six boilers each and four direct-coupled alternator groups of 1,500 kilowatts each, furnished by the Schneider Company, of Creusot. At that time it was foreseen that the station would need to be increased in the near future, and the building was erected with this end in view. The main dynamo hall was built of a considerable length, and the above plant occupied only the front half next to the river. The boiler room lay along the right-hand side, running the whole length of the building. To provide for the new outfit a second boiler room has been recently constructed against the other side of the dynamo hall, occupying a position symmetrical with the former boiler plant. The new outfit of alternator groups which has been placed in the dynamo room has a total capacity of 8,800 kilowatts and it occupies the rear space which had been left for this purpose. At present the new part of the plant consists of twenty-one boilers and four alternator groups of 2,200 kilowatts. The engines for the latter have been furnished by the Compagnie Alsacienne and the alternators by the Compagnie Française Thomson-Houston.

In one of the illustrations is shown a view of the new boiler room of the Metropolitan station. Owing to the experience which the company has had since the first boiler room lying on the other side of the building was constructed, it was able to make a number of improvements when it came to building the new section, and in the present case the new boiler plant may be said to be a model of its kind. The boilers are arranged in batteries of eight, in general, except in one case where there are but five in the battery at present. The total number of boilers which has now been installed is twenty-one, and these are now in active operation to supply the new alternator groups in the dynamo room. The boilers are of the type known as semi-tubular, which is largely used in central stations on the Continent. The fire-grate has a heating surface of five square metres for each boiler. The heating surface of the boiler itself lies near 250 square metres. An improved system of steam



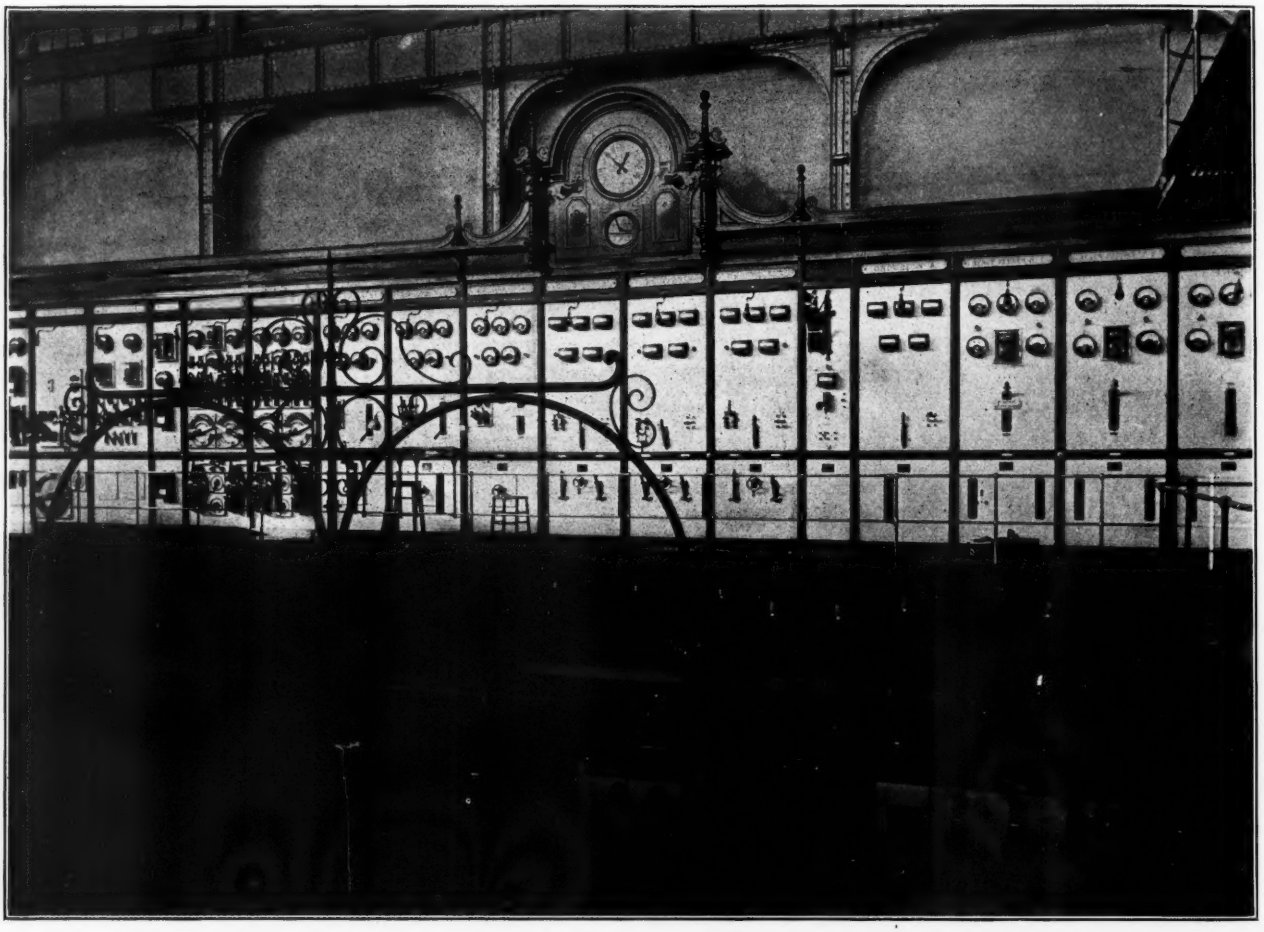
CENTRAL STATION, PARIS, FRANCE, METROPOLITAN SYSTEM.

superheaters is used with this type of boilers, consisting of two superheaters per boiler, one of which is heated by the products of combustion from the furnace, which pass through it before going to the smokestack, and a second superheater lying near the grate, which receives its heat direct from the latter. This method has a great advantage from an economical standpoint. A set of three smokestacks 180 feet high is provided for the boilers, one at the centre and one at each end of the building. An underground conduit of ample capacity passes along the range of boilers and affords a good draught.

As the building lies on the bank of the Seine it has good facilities for securing its water supply for the boilers and condensers. The new part of the boiler plant uses a large reservoir, into which the water from the river is pumped by a motor-driven outfit. From the main reservoir a second set of pumps takes the water for the boiler feed. The latter set consists of four motor-driven pumps which have a capacity of forty cubic metres per hour, with two of the pumps acting as a reserve. Between the pumps and the boilers is placed a set of Green economizers, through which the water passes before going into the boilers. In the present plant the water from the Seine, which contains a large amount of lime, is treated with a chemical solution before going into the economizers, by means of a suitable apparatus.

The main dynamo hall, which occupies the central part of the building and lies between the two boiler rooms, contains in the front part the upright engine and alternator groups, which were installed at the first period of the plant. In the middle of the hall is a space which contains a number of small generating groups. The remainder of the dynamo room is devoted to the new alternator sets, of which a view is shown in one of the engravings. The general appearance of these groups is about the same as the outfit which has been previously installed, thus giving the entire station a uniform appearance. As to construction, however, the present apparatus is of a newer type.

The engines which are represented here are of the cross-compound upright pattern, having a high-pressure cylinder of 1.150 metres diameter and a low-pressure cylinder of two metres, with a 1.50-metre stroke. These engines run at the average rate of eighty revolutions per minute. Steam jackets are used upon both cylinders, live steam being employed in the jacket of the high-pressure cylinder, while the low-pressure cylinder is heated by steam from the former. The crank shaft carries the cranks placed at an angle of 112 degrees. A very efficient system of oiling is used for the different bearings of these engines, combined with a number of sight-feed lubricators. Oil pumps take the oil which has collected in a tank below the engine and after filtering it is sent again into the piping. The present engines have a normal capacity of 3,200 horse-power and a maximum capacity of 4,200 horse-power.



SWITCHBOARD IN CENTRAL STATION, PARIS METROPOLITAN SYSTEM.

Each engine is provided with a condenser of improved pattern, and the latter are supplied by two air pumps, of which one acts as a reserve. These condensers have a circular water spray. One point to be noticed about the operating of the groups is the use of a new method of speed governing, which is useful in run-

ning the machines in parallel and in adjusting the load on the different groups. To this end each of the engines has two automatic regulators. One of these governors is placed so as to regulate the steam inlet to the high-pressure cylinder. The second governor acts upon the valve distribution of the engine. The working point of the governors is adjusted by means of a counterweight, and this can be shifted to the right position either by hand at the engine platform or from the main switchboard in the upper gallery of the station. In the latter case an electric motor is used to regulate the counterweight. This arrangement has been found to give good service and a total speed variation of fourteen per cent, or seven per cent on either side of the standard speed, can be secured.

Boiler Room in Central Station, Paris Metropolitan System.

The three-phase alternators of all the new groups have been constructed in the Paris shops of the Compagnie Française Thomson-Houston under the active supervision of Mr. E. M. Mix and the general direction of Mr. A. Garfield, chief engineers of the company. These machines have a normal capacity of 2,200 kilowatts, while they can be run for a certain time as high as 2,700 kilowatts. They are mounted upon the main shaft of the engine and are placed in the middle between the two main pillars and under the first platform. A heavy flywheel weighing eight tons is mounted beside the alternator. Besides this flywheel a second is secured by the revolving field of the machine, which has thirty-eight poles mounted on a heavy wheel. The outer casting of the alternator which holds the armature has an exterior diameter of 7.20 metres and is made in two parts bolted together. The main supporting wheel of the field is formed of eight pieces and the wheel contains eight radial spokes. The thirty-two pole-pieces are fixed to it in the usual way, making the total diameter of the field 6.10 metres. The field coils are formed of a copper strip winding insulated with varnished paper. A strip having 2.3 by 40 millimetres section is used here. The width of the outer casting of these machines is sixty centimetres and that of the revolving field forty-two centimetres. To give additional strength to the outer ring casting it is braced across by six heavy steel rods placed in the form of a star and bolted down to the casting at each end.

The laminated armature ring which is fixed in the main casting has 228 slots, making two slots per pole and per phase. The slots are lined with insulating fibre and contain copper cable of square section insulated by varnished cloth. Each slot, which has a section of seventy by thirty-seven millimetres, contains eight cables of 115 square millimetres section each, the cable having a section of 12.5 by 12.5 millimetres.

The main switchboard which is used to operate the different machines and circuits of the station is placed on one side of the dynamo room in an upper gallery. The total length of the switchboard is thirty-five metres and it is made up of thirty-one white marble panels. Of this number there are seven panels for the alternators, four for the exciters, two for the boosters, two for the storage battery, one for the direct-current machine, four for the rotaries and eight for the high-tension feeders, with the remainder for reserve and local use.

For operating the three sections of the subway a number of substations have been installed in different parts of the city. The substations receive high-tension current either from the Metropolitan central station or other plants and transform and convert this current to 600 volts direct current for operating the third-rail system of the subway. Up to the present there are six substations in operation, known as the Barbés, Père-Lachaise, Louvre, Bercy, Etoile and Opera stations. The latter plant has been added recently in order to supply part of the current for the new No. 3 section of the subway.

In general the substations are designed to contain from one to three transformation groups, each group being formed of a 700-kilowatt rotary converter, a set of step-down transformers for a primary current of 5,000 volts and twenty-five cycles, a primary and secondary switchboard, a starting group for the rotaries and motor-driven air fans, etc.

The different substations are of two kinds. The Etoile and Louvre stations are located entirely below ground, under the streets, while the remaining four plants are placed in buildings which have been erected for the purpose. The primary current is brought in each case by three-conductor cables, lead covered. Arrangements are made in the wiring so that the substations can be supplied either from the central station or by two outside stations in the suburbs of Paris, the Moulineaux or the Asnières plants. In general the primary current varies from 5,000 to 5,500 volts and the current is supplied to the traction lines at about 600 volts. The step-down transformers of the different substations are provided with a certain number of contact pieces, which allow of adjusting the voltage according to the needs of the circuits.

The current is distributed from the substations to the third rail of the subway, so that the drop in voltage is about seven volts per kilometre on the positive rail and four volts on the negative. At present the rail circuit is divided into sections, one for each substation. The machines of the latter are connected to each end of a section and work it in common, so that should one station fail to operate the rail will always be supplied with current.

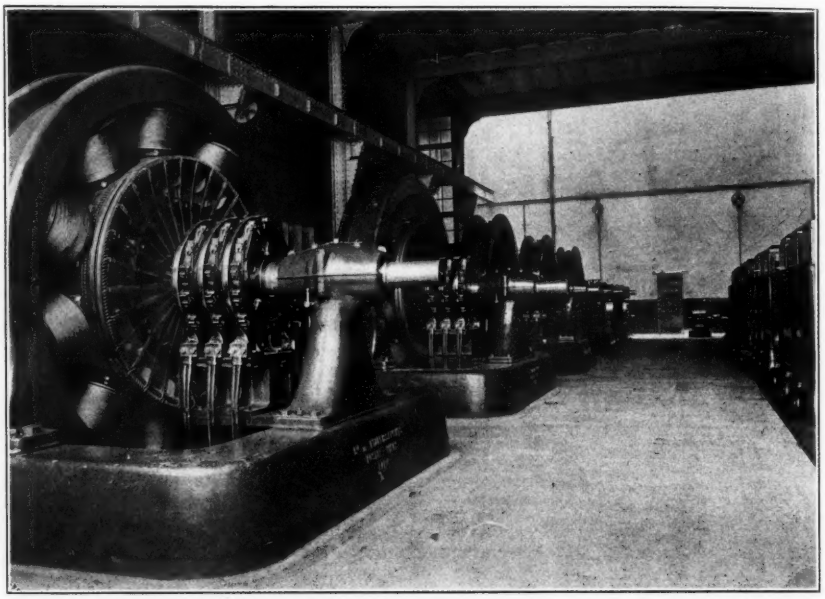
The different transformation groups in the substations which have been supplied

by the Compagnie Française Thomson-Houston are all of the same type. Each group is designed to furnish 750 kilowatts direct current at 600 volts. The step-down transformers are three in number for each group. Each transformer is wound for single-phase current. The primaries are connected in delta upon 5,000 volts coming from the main cables. The secondary coils are connected with the rotary converter, using a secondary voltage of about 350.

Two different methods are used for starting up the rotary converters. In some cases the substations contain a battery of accumulators, and these are accordingly used to start the rotaries. In other cases it has not been found advisable to use the direct current from the third-rail circuit for starting the converter groups and bringing them to synchronism, owing to the variable nature of this current due to the fluctuations of the traction circuit. To provide for the latter case the other substations have been equipped with a special group which is used for starting the rotaries. It is made up of a 600-volt generator and a non-synchronous three-phase motor of sixty kilowatts. The three-phase motor is supplied by a step-down transformer of the oil type, which serves at the same time as a starting regulator owing to the use of a double-throw switch which allows of throwing on the motor gradually so as to bring it up to the full voltage of 440. The four-pole direct-current generator of fifty kilowatts which is connected with the motor has a normal speed of 750 revolutions per minute. It has a switchboard panel containing a main circuit-breaker, different operating switches and an exciting rheostat.

The main transformers of all the substations are provided with an efficient air-cooling apparatus. They are placed in line upon a large conduit in which a current of air is forced by a motor-driven fan using a fifteen-horse-power non-synchronous motor. The latter is arranged so that it can be switched on to the different circuits of the station and it works on 370 volts, which is supplied from the main transformers.

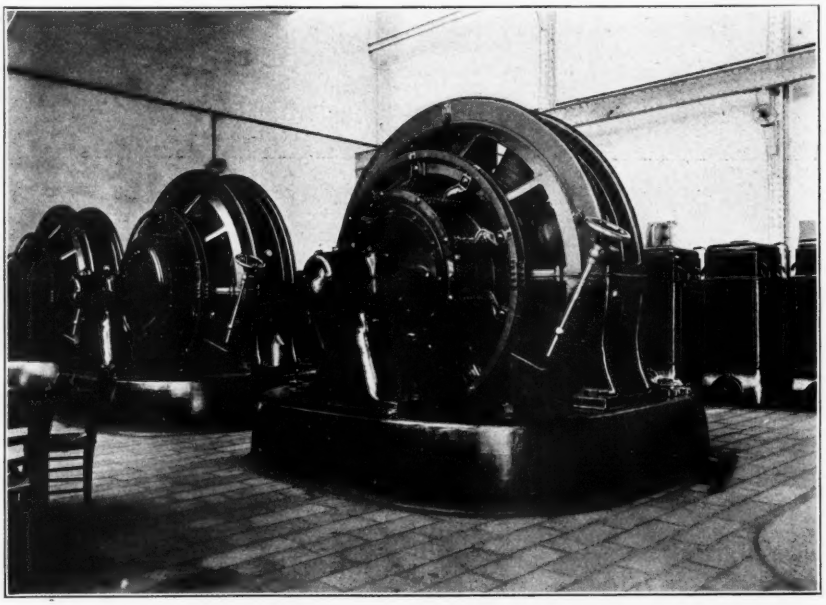
Some of the substations have special arrangements which we will mention here. In the Père-Lachaise plant is installed a large storage battery of the "Union" type containing 288 cells and giving 800 ampere-hours. The battery is used for lighting the tunnel of the subway lines, and for this purpose a special circuit has been laid in the cement of the walls. With this arrangement the tunnel is kept lighted independently of the machines. The battery is charged by a motor-generator set consisting of a 300-ampere generator coupled to a synchronous motor. This group is used as a booster and it can raise the tension 150 volts. The Père-Lachaise plant is connected by three-phase cable with the Metropolitan central station. At present there are three main rotary groups installed, but eventually the plant is to contain five groups.



BARBÉS SUBSTATION, PARIS METROPOLITAN SYSTEM.

The Barbés substation differs from most of the others in that it is connected upon a three-phase high-tension cable which comes from a central station located in the suburbs and operated by the Triphase Company. This plant as well as the Etoile substation will be connected eventually with the large central station which is now erecting at St. Ouen in the northern suburb of the city. In this case the primary line will be operated at 10,000 volts.

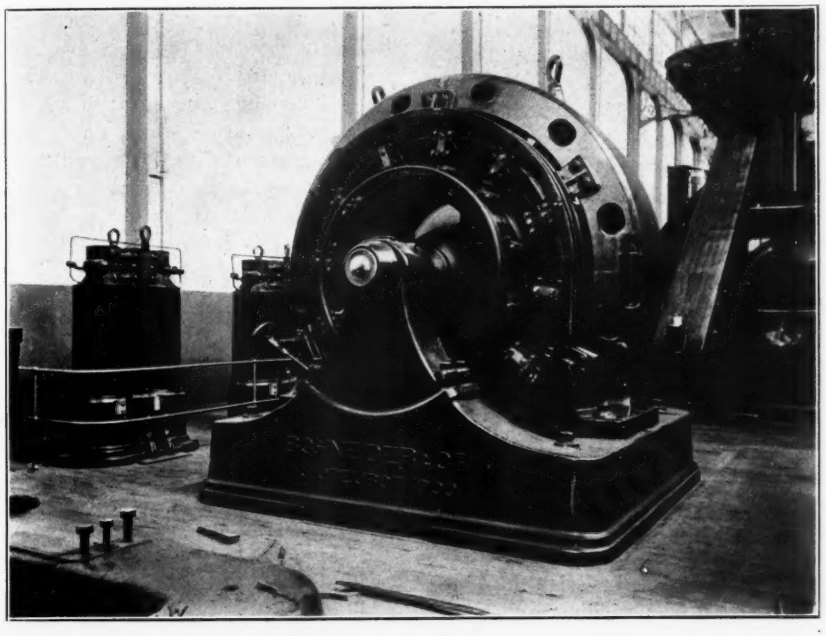
The Bercy substation, which is located in the same building with the central station, is equipped with rotary converter groups of the Ganz type, constructed in France by the Schneider Company, of Creusot. These machines have a capacity of 750 kilowatts. They are operated in



PÈRE-LACHAISE SUBSTATION, PARIS METROPOLITAN SYSTEM.

connection with transformers and a large 2,400-ampere-hour storage battery.

The Etoile substation, which is located underground at forty feet depth, consists of a main dynamo room and two rooms for the storage batteries. In the main room are installed three 750-kilowatt Schneider rotary converters of the type mentioned above and a fourth rotary of the same capacity of the Thomson-Houston make. This plant also contains a 200-kilowatt booster of the Labour pattern, consisting of a 550-volt, 300-horse-power motor running at 250 revolutions per minute coupled to a 100-volt, 2,000-ampere generator. The Etoile substation is provided with three sets of high-tension cables, so that it can be connected with the Metropolitan central, the Moulineaux or the Triphase station. It contains a large storage battery of the Tudor pattern, consisting of 270 cells, which will give 3,000 amperes on a four-hour discharge.



BERCY SUBSTATION, PARIS, METROPOLITAN SYSTEM.

The new substation which has been installed near the Opera is located in a private building and occupies the ground floor and the first and second stories. The electric outfit consists of a set of monophase transformers connected in six-phase upon rotary converters of the Schneider make. There are four of the latter machines installed. The Opera plant also contains a booster set consisting of a shunt-wound motor driving a seventy-volt, 2,000-ampere generator of the Schneider pattern. A large storage battery is placed in the upper floors. It consists of 288 Tudor cells, having about the same capacity as above.

A SELF-EXCITING ALTERNATOR.[1]

BY E. F. ALEXANDERSON.

The self-exciting alternator designed by the author can be considered as a development from the old principle of rectifying commutators. A novel feature of this machine is the automatic voltage regulation accomplished by a special application of the field rheostat. While in ordinary generators the field current is controlled by hand regulation, this machine employs a three-phase field rheostat in which the voltage drop is automatically cut down to the desired extent by a three-phase current forced through the rheostat in opposite direction to the field currents. The current used for reducing the drop in the rheostat is taken from a transformer connected in series with the armature circuit. In this way the field current is regulated with respect to the power-factor as well as to the amount of current taken from the generator.

The principles which must be borne in mind in the design of self-exciting compounded alternators are:

1. The commutation must be satisfactory with a load of any character, without shifting the brushes.

2. The compounding must be arranged so that armature reaction is compensated for, not only with variations of the load but also for changes in power-factor.

It will be shown that both of these conditions can be obtained without departing from the simplicity of a single field winding of the ordinary type which carries a direct current and is fed from two terminals connected to a rectifying commutator. Any standard type of field winding as at present applied to the ordinary type of alternating-current machinery can therefore be used with this system.

A general diagram of the author's type of alternator is shown in Fig. 1. The exciting current is generated in an auxiliary three-phase winding placed in the same slots as the main armature winding. The terminals of this auxiliary winding are connected to three sets of brushes that bear on a rectifying commutator of special type. This commutator has one active segment per pole, covering practically two-thirds of the pole-pitch, the remaining one-third of the arc being insulated. Each alternate segment is connected to one terminal of the field winding and the remaining segments to the other. By this arrangement it is possible to make the commutation independent of the reactance which is inherent in the ordinary type of field winding, and the whole process of commutation is carried out in the stationary circuits before the current enters the field.

The voltage generated in the auxiliary winding is sufficient to supply current for excitation at full inductive load; and the excitation is adjusted to the proper no-load value by a three-phase rheostat inserted in the neutral point of the auxiliary winding. Automatic compounding is accomplished by means of a series transformer connected to the rheostat. The transformer sends a current through the rheostat in a direction opposite to the field current, thereby eliminating the voltage drop in the rheostat. The elimination of the voltage drop in the rheostat changes over more or less of the field current from the rheostat to the series transformer. The secondary current of the series transformer is in phase with the line current, while the field current is practically in phase with the voltage. The amount of boosting in the field circuit will therefore depend not only upon the value of the secondary current but also upon the power-factor of the load. A function of the rheostat which is just as important as the field control is its influence on the commutation. As far as commutation is concerned, the full resistance of the rheostat may be considered as always being in circuit, although the larger part of the field current may flow through the series transformer.

As the phenomenon of commutation with this kind of rectifying commutator is entirely different from that with the

[1] Abstract of a paper read before the American Institute of Electrical Engineers, New York, January 26.

ordinary multi-segment commutator of a direct-current machine, it may be of interest to enter somewhat further into the theory of commutation in the new type of alternator. In order to understand the operation of the commutator it must be borne in mind that the field winding carries a continuous current in spite of the fact that the impressed voltage is of a pulsating character. The only fluctuation that can occur is the quite negligible pulsation needed to induce a voltage large enough to overcome the ohmic resistance

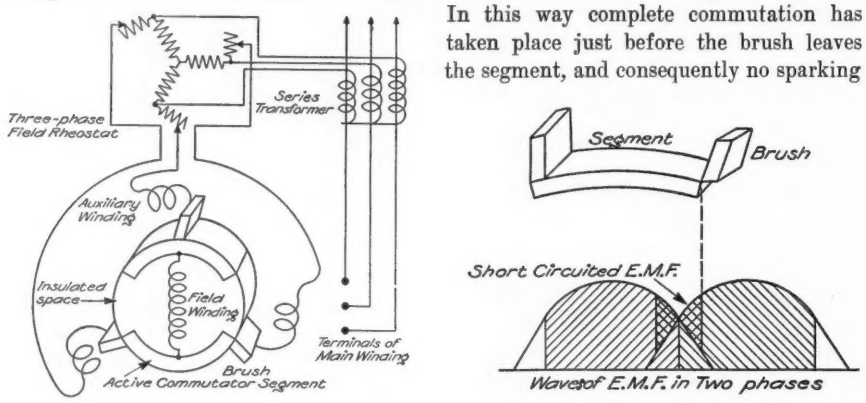
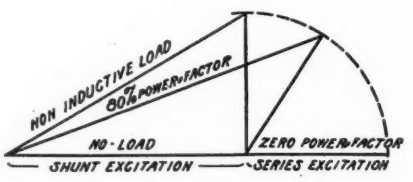


FIG. 1.—GENERAL DIAGRAM OF ALTERNATOR AND CHARACTERISTICS.

of the winding. The current in the three phases of the exciting circuit is not an alternating current of the regular sine-wave shape, but is formed of pieces, so to say, cut off from the direct current. The commutation consists in changing over the direct current from one phase of the exciting circuits to another, and occurs when one brush has come in contact with a segment and another brush is ready to leave the same segment and run into the dead part of the commutator. At this instant the current must be changed in the brush which enters the segment from zero to full value of the direct current; and the current in the other brush must be reduced from maximum to zero. Commutation should occur a little later than at the moment in which the induced voltages are equal in the two phases undergoing commutation. If we imagine that one of the brushes is leaving the segment when the voltages are exactly equal, that brush would be yet carrying a part of the field current and this current would suddenly be interrupted and changed over to the other circuit. If the stationary circuit has a high reactance the sudden change of the current would induce a voltage between the brush and the segment, and thereby cause a spark. The moment of commutation should therefore be delayed to such an extent that the difference in voltage between the two phases begins to force a cross current through the completed circuit formed by the two phases and the rheostat. As soon as the two brushes are in contact with the same segment they naturally divide the field current; but the cross current which is superimposed on the field current will weaken the current in one of the phases and strengthen it in the other phase. If, therefore, the cross current is half as large as the field current at the moment of rupture, one of the phases will carry the entire current and none will pass through the brush which is leaving the segment. In this way complete commutation has taken place just before the brush leaves the segment, and consequently no sparking will occur. The time which is required for the cross current to reach the value of one-half of the field current depends upon the reactance and resistance in the external stationary circuit.

From the preceding it is evident that whatever be the values of these quantities a position can be found for the brushes where commutation will occur without sparking. But it is also evident that a slight variation in the position of the brushes may cause severe sparking if the circuits are not properly designed. If the circuits consist of a winding with a very small resistance and high reactance, a small difference in voltage will cause a large cross current to flow between the two phases, and this cross current can not be broken suddenly without sparking. In order to obtain successful operation of the commutator the generating circuit should be designed with as little reactance as possible and with a considerable amount of resistance.



The effect of each of the different conditions which influence commutation has been determined experimentally. The most important of these conditions are:

1. Effective voltage across the brushes.
2. Effective voltage of the auxiliary winding.
3. Resistance of the stationary exciting circuit.
4. Reactance of the stationary exciting circuit.
5. Current density in brushes.
6. Velocity of commutator.
7. Amount of direct current taken from commutator.

The above quantities simply affect commutation in determining the extent to which the brushes may be shifted without causing sparking. The method of investigating how these several factors influence commutation has been to vary one quantity at a time, meanwhile keeping all the others constant. In general the results show that the range over which the brushes may be shifted without sparking is inversely proportional to the voltage across the brushes and, up to a certain limit, almost directly proportional to the resistance in the stationary exciting circuit. It is also an interesting fact that commutation is independent of the current taken from the commutator, if the voltage of the auxiliary winding and the resistance of the rheostat are kept constant.

In considering the theory of compounding self-exciting alternators it will be assumed that the rule suggested by the American Institute of Electrical Engineers, and generally accepted in calculating the regulation, is true, as it is found to agree with practice in the majority of cases. According to this rule the excitation which is needed to maintain a certain voltage at the machine terminals, neglecting the ohmic drop in the armature winding, can be found by combining the ampere-turns of the no-load excita-

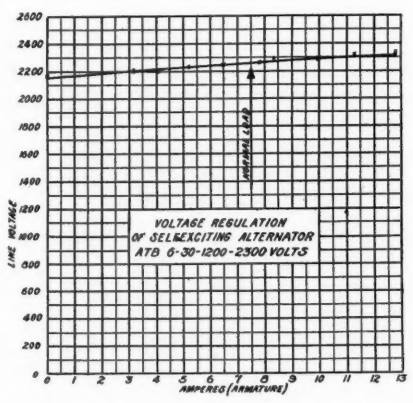


FIG. 2.—VOLTAGE REGULATION OF SELF-EXCITING ALTERNATOR.

tion with the ampere-turns of the synchronous impedance at right angles for non-inductive load; and for any other load at an angle which corresponds to the power-factor. The phases of the auxiliary winding are connected in such a manner that the voltage induced in them lags by ninety electrical degrees behind the corresponding phases of the main winding. The secondary circuits of the series transformers are closed through the rheostat and the current combines with the field current at right angles at non-inductive load, but is in phase with it at zero power-factor. At full inductive load of zero power-factor the field current in the rheostat is completely neutralized by the current of the series transformer. The effect of the series transformer on the exciting circuit is therefore equivalent to an additional electromotive force which can be combined with the electromotive force of the auxiliary winding at an angle dependent upon the power-factor. The resulting electromotive force available through this arrangement for excitation is obviously the same as that calculated by the Institute rule.

The quantities have to be slightly modified in practice to produce the exact degree of compounding or over-compounding desired. The compounding for non-inductive load can be changed at will without changing the compounding for load of zero power-factor. This is accomplished by so connecting the armature that the electromotive force of the auxiliary winding lags less than ninety degrees behind the electromotive force of the main winding. If the effect of the series transformer is considered as an electromotive force combined with that of the auxiliary winding, at approximately right angles for non-inductive load, it is evident that the resulting voltage impressed on the brushes has not the same phase relation to the voltages of the machine at full-load as it has at no-load. In order to ensure good commutation at any load it is desirable that the three-phase voltage impressed on the brushes should pass through its zero point at a given position of the commutator.

In every alternating-current generator the armature reaction for non-inductive load is a magnetomotive force tending to produce a set of poles midway between the poles excited by the field winding. The magnetic field of a loaded generator is therefore not the same as the field at no-load; it is a combination of the magnetic flux induced by the field winding and that generated by the armature reaction. The angle of displacement between the resulting field and the mechanical centre-line of the poles depends upon the design of the magnetic structure and varies widely in different types of machine. The simplest case to illustrate is a field of the high-speed turbine type in which the field winding is placed in slots, as this type offers uniform reluctance to the lines of force in all directions. The field excitation and the magnetic flux induced by the armature reaction are therefore proportional to the corresponding magnetomotive forces and combine at right angles for load of unity power-factor. When the machine is under load the resulting field is displaced from the mechanical centre-line of the poles by an angle; the tangent of this angle is the armature reaction divided by the field excitation. From this it will be seen that it is possible to design a self-exciting compounded machine so that the most favorable position of the brushes remains practically constant. If the compounding is calculated according to the Institute rule the voltage of the compounding should have a relation to the voltage of the auxiliary winding approximately the same as the armature reaction to the field excitation. On account of the armature reaction the resulting field will lag a certain angle behind the centre line of the poles; the electromotive force, however, induced by the field in the auxiliary winding is so combined with the electromotive force of the compounding that the resulting voltage is ahead of the machine voltage by approximately the same angle as the field is distorted by the armature reaction.

The fact that all the phenomena of compounding take place within the magnetic circuit of the field makes the compensation for the armature reaction instantaneous.

In parallel operation with ordinary machines, and also with other self-exciting machines, these alternators have given favorable results. When two or more over-compounded alternators are operated in parallel in the same station the series transformers should be interconnected by an equalizer bus-bar in the same way as the series fields are equalized in compounded direct-current generators. If the self-exciting alternator is to run in parallel with a separately excited generator, in order to divide the current properly, the compounding should be adjusted to correspond to the inherent regulation of the separately excited machine. When considering the parallel operation of these machines special attention may be called to a convenient method which can be adopted for synchronizing. If one generator is to be started and synchronized with other self-exciting generators, it is only necessary to bring the machine up to approximate synchronous speed, as held by the governor, and to close the main switch. The closing of the switch will cause a momentary rush of current, but the compounding of the other generators will prevent any material disturbance of the line voltage; and the machine, which has been started, will build up its field immediately. The rush of current which occurs when closing the main switch, if the generators are out of phase, is, however, not nearly so great with self-excited as with separately excited alternators.

Tests which have been made give promise of an extensive use of self-exciting machines as synchronous motors. A self-exciting synchronous motor can be either shunt-connected or compounded. Compounded synchronous motors will be found to be especially useful for boosting the voltage at the ends of long transmission lines. In this case the series transformer, which is used for compounding, should be connected in series with the main line, so that an increase of current in the rest of the system raises the excitation, with a consequent increase of leading current in the synchronous motor.

The method of starting a self-exciting synchronous motor is the same as that of starting an ordinary synchronous motor until the speed approaches synchronism. When the torque due to inductive effect begins to decrease on account of the decrease of slip the excitation impressed through the commutator becomes active and the field will receive a series of impulses—all in the same direction—which increase in strength with the decrease of slip until synchronism has been reached.

Any ordinary type of alternating-current generator can be adapted for the system of excitation and compounding described, and the experience already gained clearly indicates that it is applicable to large as well as to small units.

Bell Telephone Company, of Philadelphia.

The annual report of the Bell Telephone Company, of Philadelphia, for the year ending December 31, 1905, shows total earnings of $4,434,397.34, with a total expense of $3,155,835.08. Deducting $899,-068.50 dividends from the net earnings, there was $379,493.76 balance to surplus. The increase in net revenue was $333,-305.47. On January 1, 1906, there were 124,790 stations in service, a net gain for the year of 42,293 stations.

The Mechanics of Luminosity.

A lecture was delivered recently before the Royal Institution of London by Professor J. J. Thomson on "Some Applications of the Theory of Electric Discharge to Spectroscopy." In opening the discourse the lecturer stated that when an electric current is passed through a gas, the color of the light and the character of the spectrum depend not only on the chemical nature of the gas, but also on the nature of the current, the spectrum often being entirely different with an arc discharge from what it was with a spark discharge. Moreover, in certain cases the color of the spectrum may be entirely different in different parts of one and the same tube. These facts led to the conclusion that, owing to the bombardment of the atoms of the residual gas in a vacuum tube by flying corpuscles, the internal energy of the atoms is increased. This increase of energy requires time for it to be radiated off, and if the impacts follow each other sufficiently rapidly the value of the internal energy may be raised to a critical point at which the equilibrium becomes unstable, when the atom itself flings off a corpuscle and the shock of the discharge throws the rest of the atom into vibration, giving rise to light, which is therefore the direct consequence of atomic instability. In confirmation of this it has been found that Rœntgen rays, when they fall upon a metal, have the same penetrative power, whatever the intensity of the rays may be. If they were dragged out of the atom by the electric field of their rays, their speed and penetrative power should increase with the strength of the radiation, which is not the case. When a corpuscle strikes an atom in a vacuum tube, the internal energy of this atom is increased and may accumulate to a critical value. As soon as the gas becomes luminous there is an enormous increase in the current, a difference of one one-hundredth of a volt sometimes causing a sixty-fold increase in the current. An increase in current density tends to promote the luminous discharge, since each atom encounters more corpuscles in a given time. A single collision may be insufficient to render the atom luminous; many may be required. Hence, as the action of a magnet tends to concentrate the discharge, a tube should become luminous at a lower potential when a magnet is held near it than when the magnet is absent. If single collisions sufficed to render an atom luminous, the intensity of the light should increase proportionally to the current, but this is not the case, the increase of luminosity being more rapid than the increase in the number of cathode particles; hence to get luminosity it is necessary to raise the internal energy of the atom to a certain critical value, and the atom must not part with the energy thus received too rapidly or this critical value will never be reached. It appears that there are two radiating systems in an atom. One of these is a poor absorber of energy from the corpuscles and also a poor radiator, while the other is both a good absorber and a good radiator. For either system to give light a certain critical value of electrical pressure must be attained. If, now, the supply of energy be small, but continuous, the power absorbing and radiating system of the atom may reach a critical value and become luminous. If, on the other hand, the rate at which energy is supplied be increased, both radiating systems may be brought to the critical point; but if the energy supply be intense, though intermittent, the rapid radiating system alone may be brought to the critical point. The color of the light emitted and the character of the spectrum given depend upon which of these radiating systems be giving off light. The double spectrum of argon can be accounted for in this way. Both the vibrating systems postulated are supposed to be interior to the atom, and either the one or the other is set into vibration, according to the character of the discharge. Some significant experiments have been made by Wood, who has shown that the luminosity of sodium vapor, when it is excited by means of light, may be caused to give different spectra. By changing the character of the light, the first spectrum can be altered gradually, until finally an entirely new one is obtained. The rate at which an atom receives energy by impact depends upon the nature of the projectiles, as well as upon their kinetic energy. If corpuscles are moving at a particular speed, there is a particular speed at which the amount of energy transferred to the vibrating system will be a maximum. The speed of the corpuscles may be varied by varying the electrical pressure in the tube, hence a change of pressure may give rise to a change of spectrum. Further, if, instead of bombarding the atom with corpuscles, the projectiles are bodies of atomic dimensions, the spectrum produced will be different. It was shown that a layer of lithium salts excited to luminosity by bombardment from a cathode gives a red light, while if the bombardment come from the anode the phosphorescence is bluish-green. According to Professor Thomson's idea, luminosity is due to a critical state of the internal energy of an atom. Temperature, on the other hand, measures the energy of translation of an atom, yet a certain equilibrium must exist between this energy of translation and the internal energy; and by sufficiently increasing the energy of translation, sufficient of this may be transformed into internal energy to give rise to luminosity.

Sixth Annual Convention of the Iowa Electrical Association.

The sixth annual convention of the Iowa Electrical Association will be held at Des Moines, April 18 and 19, 1906. Headquarters will be established at the Kirkwood Hotel and facilities will be arranged for exhibitions of electrical and kindred apparatus. The following programme has been announced:

Address of welcome.

Address of president.

Reports of secretary, treasurer, executive committee and finance committee.

J. R. Cravath, Chicago, Ill. "Report on Progress."

D. F. McGee, Red Oak, Iowa. "Report of Committee on Facts and Factors."

Frank B. Rae, Jr., Lee Company, Newark, N. J. "Central Station Publicity."

C. F. Freehauf, Cresco. "Economy of Mechanical Stokers and Ash Machinery in Small Stations."

W. A. Mall, Belle Plain. "Economy of Condensing Plant in Small Stations."

L. W. Gill, Manchester. "Effect of Boiler Compounds on Engine Lubrication."

J. A. Innes, Eagle Grove. "Line Losses and Economical Distribution."

A. W. Zahm, Mason City; H. G. Gorr, Dubuque. "Care and Maintenance of Meters."

C. E. Stanton, Dubuque; Niels Christensen, Waterloo. "Some Practical Experiences with Steam Turbines."

H. G. Gorr, Dubuque; Thos. Sloss, Cedar Rapids; W. P. Caspar, Keokuk. "Experiences with Grounded Secondaries."

J. P. Jones, Cedar Falls; F. H. Richardson, Boone; W. J. Greene, Cedar Rapids; J. Walsh, Davenport. "Effect of a Day Load on Station Economy."

Professor Geo. D. Shepardson, University of Minnesota, Minneapolis, Minn.

W. S. Mead, Parkersburg; O. E. Brownell, Lake City; Jos. Hutchinson, Manchester; Thos. Ferris, Osage. "Ways and Means of Increasing Business in Towns Under 5,000."

Professor G. W. Bissell, Iowa State College, Ames. "Depreciation of Electrical Properties."

Honorable L. Y. Sherman, Lieutenant-Governor of Illinois, Springfield, Ill. "Unreasonable and Unrestrained Rate Agitation."

George McLean, Dubuque. "Equitable Rates."

Mr. Hurd, of Hurd, Lenehan & Kiesel, Dubuque. "Legal Status of Rate Regulation."

Honorable M. J. Wade, Iowa City. "Political Status of Rate Regulation."

IRON-CORED ALTERNATE-CURRENT INSTRUMENTS.[1]

BY W. E. SUMPNER.

Alternate-current instruments of the induction or eddy-current type have been in use for some years, and in these instruments iron cores are employed. They have proved useful and convenient in practice, and much skill has been expended in constructing and developing them. But it can not be maintained that such instruments obey any known and precise law. The mathematical theory of an eddy-current problem can only be worked out in a few simple cases, while the structure of an actual instrument of this type involves conditions so complex that satisfactory mathematical treatment is out of the question. It is thus only possible to develop working theories of a rough approximate kind for the action of these instruments, and their readings can only be relied on when the exact conditions of testing are reproduced.

During the last year I have devoted much attention to the problem of constructing accurate electromagnet instruments for alternate-current working. The model selected for imitation has been the permanent magnet moving coil instrument for direct-current circuits. Of course the permanent magnet has been replaced by an electromagnet. It has been found possible to construct iron-cored instruments for use as ammeters, voltmeters, wattmeters, etc., such that their scales can be determined from tests in which only direct-current measurements are involved and such that their readings are independent of frequency and wave-form.

The instruments are all characterized by having a moving coil circuit and a fixed electromagnet. Instruments of this kind are novel in alternate-current working. A little consideration will soon show that difficulties in regard to their accurate working are most likely to arise from the action of the electromagnet. As regards the moving coil, this will be turning in a field the strength of which can easily be made as strong as, and even far stronger than, that of a permanent magnet instrument, so that only a minute current and but few turns will be needed. It is thus possible to use a large non-inductive resistance in series with the coil, so as to render quite negligible any effects due to self or mutual induction. The question of accuracy, therefore, entirely turns upon the behavior of the electromagnet.

Now, there are many causes at work tending to prevent an electromagnet excited by an alternating current from acting in the exact way wanted; but the errors which arise are easily grouped under two heads. The magnetism produced may differ from what is required either in its amount, or in its phase and wave-form. We may thus class the errors of the magnet as either magnitude errors or phase errors. Experience soon shows that the latter are far the more important.

It does not necessarily follow that an error in the magnet will cause an error in the instrument readings. Thus for an ammeter it is not necessary for the magnetism of the field to be proportional to the magnetizing current. All that is needed is that the flux density at a given part of the gap must always be the same for the particular current which deflects the coil to that position in the gap. For an ammeter the coil is not needed in the same position for two different currents, so that variation in the reluctance of the magnetic circuit will only affect the calibration of the scale, just as variation of the gap length at different deflections will affect such calibration. For a wattmeter this is not the case, since, owing to variations in voltage or power-factor, a given deflection may be required for currents of very different magnitude. In such an instrument it is necessary for the flux density at each position in the gap to be proportional to the magnetizing current for all working values of the latter. The resulting instrument error is, however, not of a serious character, for if the greatest variation from proportionality is two per cent, the greatest error of the wattmeter due to this cause will only be two per cent, and will be an error independent of the power-factor of the circuit and affected only by the magnitude of the current.

Now as regards errors of magnitude, there are only two causes which tend effectively to vary the reluctance of the magnet. These are eddy currents and changes in the permeability of iron. The effect of eddy currents at ordinary frequencies can easily be made negligible by suitable lamination, and the influence of the air-gap is very great in steadying the reluctance of the magnetic circuit. With ordinary dimensions of instruments the reluctance of even a narrow air-gap will be very large compared with that of the iron path, so that a large change in the permeability of the iron will be needed to affect appreciably the reluctance of the whole circuit. But a great change in permeability is not likely to occur. In the first place a high induction density is not needed. The field in the best permanent magnet moving coil instruments rarely exceeds 700 lines per square centimetre, and it is not necessary to have it greater in alternate-current instruments. Moreover, a high density across an air-gap of as little as one-eighth inch needs an undesirable number of ampere-turns in the field coil. Hence the flux density in the iron will only reach moderate values, for which the permeability of the iron will be fairly constant, and the reluctance of the whole magnetic circuit will not vary appreciably if the air-gap is short, and practically all the lines cross this gap by a short path. I find, however, that if the air-gap is large magnetic leakage effects become serious, not so much because the waste field is large, but because the leakage factor varies with the current. If this leakage factor is constant, that is to say, if the mode of distribution of the lines remains the same, there is a definite meaning to the reluctance of the magnetic circuit, and this reluctance will be more and more constant for different currents the greater the gap used. But if, owing to changes in permeability of the core, the mode of distribution of the lines alters, the same effect is produced as if the gap itself varied for different currents. Now, with a large air-gap the leakage factor is in general large and appreciably dependent on the strength of the current, the result being that the flux density at a given part of the gap is not sufficiently proportional to the total flux in the iron.

For an ammeter none of these effects matter. Only the calibration of the scale can be affected, and a narrow air-gap may be used, so that a sensitive instrument can be produced. With a wattmeter the case is far otherwise if the magnet is excited by the current. For although, if a narrow air-gap is used, magnitude errors become comparatively unimportant, the phase-error due to hysteresis under these circumstances is, I find, so large that the instrument becomes hopelessly inaccurate. Nor does there appear any prospect of making satisfactory iron-cored wattmeters with a series exciting coil. The hysteresis error can only be reduced by using a large air-gap, causing serious trouble owing to magnetic leakage, and practically throwing away all the advantages in the way of sensitiveness associated with iron-cored instruments.

There remains for consideration the second and much more serious sources of error in these instruments—*viz.*, phase er-

[1] Abstract by the author of an original communication which has been accepted for publication in the *Journal* of the Institution of Electrical Engineers of Great Britain, reprinted in *The Electrician*, London.

rors. Before studying these, reference may be made to Figs. 1 to 4 which show how the instrument may be connected to the circuit for the various purposes of an ammeter, a wattmeter or a voltmeter. The instrument has two circuits, each of which may be connected with the mains in series or in shunt. There are thus four cases to consider. Figs. 1 and 2 represent the ammeter and wattmeter, each with a series-wound electromagnet. Figs. 3 and 4 represent shunt magnet instruments, the former denoting a voltmeter and the latter a wattmeter. In Fig. 3 the moving coil C is put across the mains in series with a condenser K. In Fig. 4 the moving coil C forms part of a circuit, including a large non-inductive resistance R and the secondary S of a small transformer whose primary P is traversed by the main current. This transformer must have a magnetic circuit of constant reluctance.

In both these cases the moving coil current is in quadrature with the electrical quantity producing it. Thus in Fig. 3 it is proportional to the rate of change of the voltage, while in Fig. 4 it is proportional to the rate of change of the current. The reason for securing this quadrature relationship is to be found in the action of the electromagnet when excited by the voltage of the mains. With a magnet of good design the induced voltage in the windings due to the changing magnetism in the iron will be so large compared with the copper drop that the former will not appreciably differ from the voltage of the mains. The magnet flux F and the line voltage V will be in quadrature, since V will be proportional to the rate of change in F. The moving coil current C will be caused by Q, the second electrical quantity affecting the instrument. In Fig. 3 Q is the line voltage V, while in Fig. 4 Q is the load current A. Thus the average product of VQ is either the square of the voltage for Fig. 3 or the power in watts for Fig. 4. The deflection of the instrument is dependent on the average product of CF. Now, it can be proved mathematically that whatever the frequency or wave-form, the mean value of VQ is proportional to the mean value of CF, provided exact quadrature relationships are obtained—that is, if V varies as the rate of change of F and if C varies as the rate of change of Q. Under these circumstances the deflection of the instrument will measure either the voltage or the watts if the instrument connections are those of Fig. 3, or of Fig. 4, respectively. Small phase errors must occur in actual instruments, but they can be so reduced that the resulting instrument errors become negligible in practice.

The shunt magnet has a striking property most valuable for instrument purposes. Its magnetism is determined by the voltage, and variations in the permeability of the core do not alter the ratio between the two. If the voltage doubles the magnetism must also double, whether the permeability varies or remains constant. This statement is mathematically accurate if the resistance of the winding is zero. The coil must, of course, have

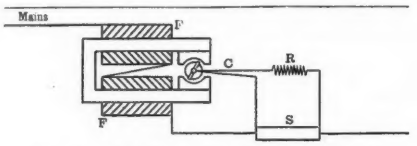


FIG. 1.—AMMETER WITH SERIES-WOUND ELECTROMAGNET.

some resistance, and a phase error is therefore introduced owing to the copper drop; but experience with a number of new instruments has proved that it is easily possible to design the electromagnet so that for all ordinary frequencies the copper drop is negligible compared with the applied voltage. It is thus true, for practical purposes, that shunt magnets can be made such that the flux of magnetism is accurately proportional to the applied voltage, even when the induction density ranges from very low to very high values. Of course, the magnetism is not in phase, but in quadrature, with the voltage. This at first sight appears to render the instrument problem difficult. As a matter of fact, it makes it much easier of solution.

The characteristics of the electromagnet when excited by a series or shunt-winding form a striking contrast. With the series magnet the variation of the ratio of magnetism to current, or in their phase rela-

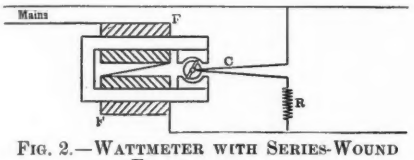


FIG. 2.—WATTMETER WITH SERIES-WOUND ELECTROMAGNET.

tion, is entirely caused by the properties of the core. With the shunt magnet any change in the ratio of magnetism to voltage, or in their phase relationship, is entirely due to the resistance of the winding. There is another point of contrast which, though not so apparent, is quite as important. With the series magnet the chief source of error is the phase difference between magnetism and current due to hysteresis. For ammeters this is not important, as a fairly large phase error is allowable without introducing appreciable error into the instrument readings; but for wattmeters it is vitally important to make this phase error small, and the only way of doing this is to use a large air-gap. Thus, with the series magnet, the condition for accuracy is opposite to the condition for sensitiveness. With the shunt magnet, on the contrary, the shorter the air-gap the more sensitive, and also the more accurate, the instrument becomes, since the copper drop diminishes with the gap. For these reasons voltmeters and wattmeters should be constructed with shunt magnets. For an ammeter a series magnet must be used, but in this case the errors due to hysteresis and varying permeability can be made negligible even when the gap is small.

A thorough investigation shows that the electromagnet, whether it is to be used in series or in shunt, must be so designed as to secure the same condition of construction. This condition is that the copper drop in the winding must be made sufficiently small, but not too small, in comparison with the total voltage absorbed by the winding. For a given number of turns in this winding it is always advantageous to reduce the resistance as much as possible, and the impedance must always be made large, but there is no advantage in making it larger than is necessary to sufficiently diminish the phase error, and to produce a strong magnet. The copper drop reckoned as a percentage of the coil voltage may be much larger for ammeters and voltmeters than for wattmeters, and it is in consequence easier to design the former instruments than the latter, but in nearly all respects the suitability of the electromagnet is directly determinable from the copper drop.

For a detailed proof of all these statements I must refer the reader to a long theoretical and experimental investigation just printed, in the form of an original communication, by the Institution of Electrical Engineers. It is needless to point out the advantages of iron-cored instruments. These advantages are universally acknowledged. Everything turns upon the accuracy of such instruments, and this can only be established by a careful and thorough investigation of their errors. This has been done both mathematically and experimentally in the communication referred to. The errors found are shown to be in strict accordance with the theory. It is also shown that the magnitude of these errors is reducible to a negligible amount. This is particularly the case with ammeters and voltmeters, the frequency error of which is reducible to less than one-tenth of one per cent for a range of

frequency of three to one, while errors due to varying wave-form are non-existent. High accuracy in wattmeters, just like high efficiency in transformers, can easily be obtained if sufficient iron and copper are used in their construction. For designs equally economical in material, and such as to secure the same degree of accuracy, the weight of the wattmeter must be greater for circuits of low frequency or low power-factor, than for circuits of high frequency or high power-factor; but experience proves that there is no difficulty in constructing a wattmeter suitable for any ordinary working conditions, such that its weight does not exceed that of an ordinary permanent magnet instrument. Ammeters and voltmeters are essentially the same as wattmeters used on circuits of unity power-factor, hence their weight can be much reduced in comparison with that of wattmeters, and it is unnecessary to pay much attention to economy of material in their design.

Instruments of this kind have the characteristics of those of the dynamometer type, and may be used as ammeters, voltmeters or wattmeters, in accordance with the way the two windings are connected with the circuit. Several of the instruments made have, in fact, been used in all three ways. The markings of the scale have been determined from direct-current measurements, and the scale reading has proved proportional to the watts when the instrument has been used as a wattmeter, and also a measure of the square of the amperes or of the square of the volts when the same instrument has been used in either of the other two ways.

Present limitations of space prevent more than a brief reference to the nature and extent of the instrument errors due to incorrect phase relations. Each of the instruments has two windings, and each of these windings is subject to the influence of one of the electrical conditions (voltage or current) of the circuit. If ϕ is the phase difference of these two electrical conditions, and if $\phi + \theta$ is the phase difference between the magnet field and the moving-coil current, θ is the phase error, and the torque, instead of being proportional to cos ϕ, is proportional to cos $(\phi + \theta)$. The true reading of the instrument will bear to the actual reading the ratio of the cosines of these angles. If ϕ and θ are both fixed the ratio of the above quantities will also be fixed, and there will be no instrument error, since only the constant to be used with all parts of the scale will be affected; but if either ϕ or θ varies, the instrument error is measured by the greatest change in the above ratio under working conditions. Now, with an ammeter or voltmeter ϕ is not only fixed, but it is zero, since for these instruments the two electrical conditions affecting the windings are the same, being both the main current, or both the main voltage, respectively. The error in these instruments is thus measured by the greatest change in the value of cos θ.

For an ammeter θ is the phase error due to hysteresis. It is independent of frequency, and, although not small in amount when a narrow air-gap is used, it only varies very slightly with the current, so that cos θ, which is always very close to unity, is essentially constant, and, as a matter of fact, the instrument error can be made inappreciable in practice.

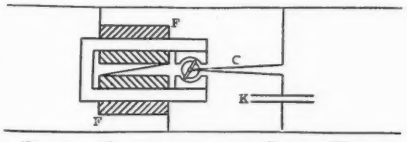


FIG. 3.—VOLTMETER WITH SHUNT WOUND ELECTROMAGNET.

For a volmeter it can be shown that the error-factor is

$$1 - \tfrac{1}{2}\theta_r\,(\theta_r + \theta_i + \theta)$$

where θ_r is the copper drop, which I find can be reduced to 0.5 per cent on circuits of fifty cycles; θ_i is the hysteresis phase error, which for narrow air-gaps may be ten or fifteen per cent; and θ_k is the power-factor of the condenser, which can be taken as about two per cent; so that the error-factor need never differ from unity by as much as one part in 3,000, its variation is utterly negligible, and the instrument error can be made far too minute to be detected.

For the wattmeter a totally different state of things holds good. ϕ is no longer constant, since cos ϕ is the power-factor of the load, and the percentage error, in taking cos $(\phi + \theta)$ as a measure of cos ϕ, can be shown to be θ tan ϕ, where θ is measured as a percentage of a radian. Taking as a representative load one of power-factor 0.707, for which tan ϕ is unity, it appears that θ must be reduced to one per cent of a radian if the instrument is to measure accurately to one per cent on circuits of such power-factor. For the wattmeter θ is the sum of three-phase errors,

$$\theta = \theta_r + \theta_s + \theta_i$$

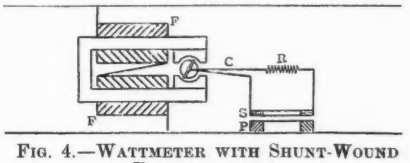


FIG. 4.—WATTMETER WITH SHUNT-WOUND ELECTROMAGNET.

where θ_r is the copper drop, which on fifty-cycle circuits can be reduced to 0.5 per cent and even less; θ_s is the self-induction error of the moving coil circuit, which with air-core transformers can be reduced to 0.2 per cent or less; while θ_i is the hysteresis phase error of the current transformer, if this has an iron core or shield. θ_i is zero for an air-core transformer, and is very small if the transformer is merely shielded from extraneous fields by laminated iron. The magnetic circuit of a current transformer, having an iron core through its coil, must contain a large air-gap, or the phase-error will be too great, just as in the case of series electromagnets; but there is no difficulty, even in this case, in reducing θ_i to less than one per cent with a suitable design. The total phase-error of the wattmeter can, without difficulty, be reduced to one per cent, corresponding with a one-per-cent error in the readings on loads of power-factor 0.7, as compared with non-inductive loads.

NOTE ON THE EXPRESSION, "CURRENT DENSITY."

BY D. TOMMASI.

The expression, "current density," which is so constantly employed in theoretical and practical discussions, is not always as explicit as could be wished. Particularly in electrochemistry the current density plays an important part, since it can bring about modifications of the physical and chemical properties of the bodies set free by the decomposition of the electrolyte. For example, with a low-current density metals are generally deposited in a very adherent manner and have a crystalline form. On the other hand, with a greater density they are ordinarily precipitated in the form of a black or brown powder, which does not adhere to the cathode. The metals the most easily oxidized are deposited on the cathode as oxides when the density of the current is low and in the metallic state when it is large.

Ordinarily speaking, the term, "density of the current," signifies "the quotient of the intensity of the current divided by the surface through which it passes"; or, what amounts to the same thing, the amperes per square inch of the surface of the electrodes. Even though the units employed in determining the current density be known, there is a certain confusion regarding the surfaces to be reckoned. Thus it is desirable that electrochemists should be careful of the use of this expression. There are two factors to be measured: one is the intensity of the current and the other the surface, and it should be stated definitely whether it be the surface of one electrode only, or of both together, which is given.

Effluviography, or Obtaining Images by Means of Obscure Effluvia.

To the Editor of the Electrical Review:

Apropos of X-rays, Rœntgen rays, fluorescent rays, etc., as discussed in the Electrical Review for January 6, may I call your attention to a note by myself in 1886—that is to say, six years previous to the discovery of Professor Rœntgen relative to X-rays? I sought to obtain an impression on a photographic plate without the use of light, solely by the action of obscure effluvia. The following is a quotation from my note presented to the Academy of Sciences, Paris, March 22, 1886:

"I have the honor to submit to the judgment of the academy the first results of my researches on the means of obtaining, by the action of electrical effluvia alone (obscure discharges), the effects which one obtains by means of light in photography. In order to photograph objects without the use of light—or, to speak more exactly, effluviograph—the following arrangement was employed provisionally: two metallic arms, placed parallel with respect to one another, are each connected to one pole of a Holtz machine. A bromide-gelatine plate is placed perpendicularly to the arms so that the plane of the sensitized face contains the sides of the arms, or is very close to it in the two directions. Current is established, an application for a few moments being sufficient. I did not take pains to carry out the experiment in complete darkness. The plate is then developed by the ordinary process, and is found to be altered as if it had been exposed to light. This experiment proves that the effluvia produce the same effects as ultra-violet rays."

In order to assure myself that the electrical discharges gave rise to rays other than actinic rays, the following test was made: on a bromide-gelatine plate a small piece of printed paper was placed, and the whole was put in a holder. This was wrapped up in such a way that after a certain time of exposure to light no alteration was produced. It was then certain that the wrapping was completely opaque—that is to say, the protection against luminous rays was absolute. Above the holder thus enveloped electrical effluvia were produced, the light of which—not more than that of day—should influence the sensitive plate. Now the action took place, and an image was obtained, developed and fixed which was identical with that which would have been obtained from luminous rays. I therefore concluded that electrical discharges contain, in addition to actinic rays, that particular kind of ray which I call electric rays, and of which I have shown directly the existence, and that they are given out from obscure effluvia—that is to say, effluvia destitute of luminous rays.

D. Tommasi.

Paris, February 3.

Systems of Workingmen's Insurance and Employers' Liability Funds.

The Bureau of Labor is preparing a report covering the various systems of workingmen's insurance and employers' liability both in this country and abroad. The report will cover insurance against sickness, accident, disability, old age, death and unemployment.

In this connection it is endeavoring to secure information concerning the existence in the United States of what are usually known as establishment funds—that is, mutual relief or insurance funds organized and maintained by the employés of an industrial establishment, or relief funds supported either wholly or in part by the employers themselves. It is desired to obtain, wherever possible, copies of constitutions, rules and by-laws, blank certificate forms and any other matter relating to funds of this character. In the absence of other data the name and location of establishments in which such funds exist are desired. Persons possessing data of any kind relative to the existence of establishment funds in this country are requested to communicate with Charles P. Neill, Commissioner of Labor, Washington, D. C.

Convention of the Branch Managers, Officers and Department Heads of the Crocker-Wheeler Company.

The annual convention of the branch managers, officers and department heads of the Crocker-Wheeler Company was held at Ampere, N. J., from January 24 to January 27. Branch managers were present from all parts of the country, reporting a considerable increase in business during 1905, not only booking more business than in 1904, but more than was booked during January, 1903. The Crocker-Wheeler line of transformers has been successfully developed and marketed during the past year and the selling men were particularly satisfied with its inception. Other lines of electrical machinery are about to be taken up and in these the convention expressed great confidence. The progress of the company in the alternating-current field is also worthy of note.

Branch Managers and Officers' Convention, January 24-27, 1906, Crocker-Wheeler Company, Ampere, N. J.

The accompanying illustration is a reproduction of a photograph taken during the convention. Those in the top row, beginning at the left, are F. W. Kreps, W. C. Appleton, H. M. Gassman, H. Fuller, B. A. Schroder, S. Russell, Jr., C. W. Startsman, J. R. Wilson, H. A. Brown, H. J. Sage, H. C. Petty, H. C. Baker, Harold Lomas, R. N. C. Barnes, H. B. Hussey, Julian Roe, L. M. Ward, Rodman Gilder, C. N. Wheeler, M. E. Weissblatt, L. S. Horner, E. Heitmann, A. Hartmann, W. F. Sullivan and H. Pikler. Second row—J. B. Milliken, H. L. Patteson, W. L. Brownell, A. L. Doremus, S. S. Wheeler, G. S. Dunn, W. A. Doble, F. B. Degress and G. W. Bower.

The Faraday Society.

The eighteenth ordinary meeting of the Faraday Society was held on Tuesday, January 30, 1906, at the Institution of Electrical Engineers, London, England. Professor A. K. Huntington in the chair.

The following nominations for the officers and council, to be elected at the forthcoming annual general meeting, were announced:

President—Lord Kelvin.

Vice-presidents—Professor A. Crum-Brown, Professor W. Hittore, Sir William Huggins, Sir Oliver Lodge, Ludwig Mond, Lord Rayleigh, Professor J. J. Thomson.

Treasurer—F. Mollwo Perkin.

Council—Bertram Blount, W. R. Cooper, Professor A. K. Huntington, R. S. Hutton, Herbert Jackson, T. M. Lowry, W. M. Morrison, O. J. Steinhart, J. Swinburne, Professor E. Wilson.

Mr. W. Murray Morrison read an abstract of a paper presented by M. Adolphe Minet on "The Electric Furnace: Its Origin, Transformations and Applications. Part III."

The previous sections of the paper, which is of a classificatory and historical character, dealt with the first or laboratory period of the development of the electric furnace. The second period, inaugurated by the researches of the brothers Cowles and of Héroult (1886-1887), saw the birth of industrial furnaces and the beginnings of three new industries—the electrometallurgy of aluminum, the electrometallurgy of sodium and the preparation of refractory materials. The present paper deals almost entirely with the first of these industries.

The methods for the manufacture of aluminum are divided into two principal groups—electrothermic methods, which produce the metal alloyed with copper or iron or combined with carbon, and electrolytic methods, which yield pure aluminum. The furnaces of Cowles, Borchers and Willson, the early type of the Héroult furnace, and the Minet "mixed" furnace are described, among others, under the former heading. The principal electrolytic furnaces dealt with are those of Héroult, Minet and Hall, and finally some of the more recent suggested improvements in the electrometallurgy of aluminum are briefly outlined.

Mr. E. Ristori added some interesting details in connection with the early work of Héroult and others. Kleiner, in 1885, had unknowingly decomposed bauxite and produced small quantities of aluminum.

Mr. W. M. Morrison pointed out that Héroult's invention was actually made in 1885, although his patents only dated from 1887.

Dr. O. J. Steinhart referred to recent patents of Hall for purifying bauxite electrically, and of Betts for depositing pure aluminum from an impure electrolyte.

Mr. Bertram Blount said that, although the purification of the bauxite was the whole crux of the aluminum problem, yet now there might be found uses for impure aluminum in connection with "thermit" welding. He discussed some of the developments that had taken place in the general design of electric furnaces.

Mr. F. W. Harbord, in reply to a question, said that calcium might, if it could be made cheaper, replace aluminum for getting rid of over-oxidation in steel, but it had not yet been really tried.

Dr. J. A. Harker then gave a demonstration of a solid electrolyte tube furnace.

The furnace was designed for uses in which the presence of hydrocarbons or other reducing gases, inseparable from a carbon tube furnace, was undesirable. It has, in particular, been used for calibrating thermo-couples and determining the melting point of platinum, which the author gives as 1,703-1,713 degrees centigrade. The furnace is practically an overgrown Nernst lamp, consisting of a tube made of a mixture of zirconia and ten per cent yttria, which is squirted through a die and then baked. The small type shown in operation was two and one-half inches long between the contacts. When taking one ampere at about 120 volts a temperature of 1,600 degrees centigrade was attained. The tube is made conducting either by heating direct, or else by surrounding it with an external nickel heating coil, separated from it by a layer of pure zirconia, the combination forming a "cascade" type of furnace. Special attention has to be paid to the contact of the platinum leading-in wires and the tube.

With regard to the mechanism of conduction through Nernst conductors the author thought that a comprehensive and satisfactory theory was at present lacking. It was, however, certain that the conduction was electrolytic, because by pumping away the atmosphere surrounding a Nernst glower, to prevent recombination, a metallic filament could ultimately be obtained.

Mr. Bertram Blount thought no special mechanism was needed to explain solid electrolysis. Ordinary transference of ions would take place in a semi-plastic mass.

Dr. T. M. Lowry referred the author to the dissertation by Reynolds. The conduction was similar to that which occurred in hot glass.

Mr. E. B. R. Prideaux communicated a paper entitled "Note on the Production of Ozone by Electrolysis of Alkali Fluorides."

When a concentrated aqueous solution of hydrofluoric acid or of a fluoride is electrolyzed the action of nascent fluorine on the water produces ozone in considerable quantities, and this might, conceivably, have commercial importance. The electrolysis of potassium fluoride is more promising than that of hydrofluoric acid; with dilute solutions of the latter only 0.23 per cent of ozone was easily obtained by the author. The largest yield obtained with the former, however, was only 0.65 per cent of ozone in twenty minutes. Variations of current density did not much affect the yield, but this fell off as the duration of the experiment was increased. The experiments were made in a U tube of thin glass coated inside with paraffin and vaseline and immersed in ice-water. The cathode was of copper, and the anode of platinum.

A Mechanical Registering Electrometer for Atmospheric Electricity.

A brief description is given by Herr Hans Benndorf in the *Physikalische Zeitschrift*, Leipsic (February 1), of an ingeniously arranged electrometer, having for its purpose the recording of atmospheric electrical disturbances. The device consists essentially of a quadrant electrometer, a long pointer, a roll of paper moved by clock-work and an arrangement for marking the signals upon the paper. The quadrant electrometer is of the usual type, but is suspended from a bifilar arrangement by means of an insulating sulphur connector. Just above this connector is attached a needle twenty centimetres long, made of aluminum wire, which is counterbalanced. This needle projects over the recording strip, which is moved through a clock mechanism at a given rate. Arranged above the needle is a light bar actuated by an electromagnet, so that when the latter is magnetized the needle is struck downward against the paper. At this point the paper is raised slightly by means of a small rod. Placing a piece of carbon paper over the recording paper, a mark is made upon the latter whenever the magnet is actuated. The electrometer is damped by means of a vane immersed in sulphuric acid, which serves also for the electrical connection to the needle. The apparatus is arranged so that once or twice during the day the quadrants are connected to the earth and the zero point thus recorded.

A Large Power-House for Washington, D. C.

An important feature of the general plan for extension and development adopted by the Potomac Electric Power Company, Washington, D. C., sometime ago is the closing of a contract with J. G. White & Company, of New York city, for the erection and equipment of a new power-house for both lighting and power. The Potomac Electric Power Company is the principal railway interest of the Washington Railway and Electric Company, which divides with the Capital Traction Company the control of the electric traction business in Washington, D. C. At the present time 650 cars are operated over about 150 miles of track. The mileage of the Capital Traction Company is between forty and fifty miles.

The ultimate cost of the power-house will be in the neighborhood of $1,500,000. The building is to be approximately 166 feet by 183 feet by sixty-seven feet. It will be of steel frame construction with curtain walls, which will probably be constructed of moulded concrete blocks. The boiler room will contain four rows of boilers, with three chimneys located between the second and third rows. There will thus be two divisions of the firing floor, each serving two rows of boilers. The turbine room will be at right angles to the firing room, and will have no basement, its floor lying in approximately the same level as the boiler room basement.

Two 2,000-kilowatt and one 5,000-kilowatt Curtis turbines will comprise the first installation, together with boilers and superheaters. The building is designed for a future installation of two additional 5,000-kilowatt Curtis turbines, with steam generators, making a power-house of 19,000 kilowatts ultimate capacity. Galleries will be built around all of the units, connecting by short bridges, permitting of easy communication, making, in effect, a secondary operating floor in the turbine room. The turbines will generate twenty-five-cycle, three-phase current at 6,600 volts for distribution directly to the substations. The two 2,000-kilowatt units are already installed, one of them being equipped with an ordinary type of surface condenser. All of the remaining units will have the latest type condensers, self-contained in the basement of the turbines.

The intake and overflow conduits for the condensing water will run underneath the turbine floor approximately at the centre line. There will be a small coal bunker over the firing floor of each boiler, but the main storage room for coal will be outside of the power-house, back of the boiler room. Necessary means for distributing the coal will be installed, the coal to be delivered from railroad cars in the storage room, and reclaiming it and delivering it to a system of conveyers, which will distribute it among the bunkers. Cars running underneath the boilers will collect the ashes, and the same apparatus which distributes the coal over the storage area will be used for collecting the ashes from the cars and delivering it into railroad cars for disposal.

Mechanical stokers supplied from overhead bunkers will feed the boilers, which will carry 175 pounds steam pressure. Superheat will be at 150 degrees at the same pressure. All of the auxiliary machinery, with the possible exception of the coal-handling apparatus, will be steam driven, and all of these prime movers will exhaust into feed-water heaters.

The controlling apparatus will be entirely contained in a switch house adjoining the main generating room. All apparatus will be distributed among three galleries. The first gallery will contain the outgoing feeders and main generator leads. The second gallery will contain all the bus-bar compartments, disconnecting switches and static apparatus, together with instrument transformers. The third gallery will contain both alternating and direct-current switchboards. The number of exciting units has not yet been determined, but there will probably be two or three in the first installation. In any case a booster battery will be installed with the plant, capable of performing alone the excitation function for the whole generator equipment for the period of one hour.

Wireless Telegraphy on Trains.

United States Consul Daniels, of Sheffield, England, reports that, by license of the postmaster-general, the Midland Railway Company is conducting a series of experiments in the vicinity of Derby to determine whether wireless telegraphy can be used in connection with their fast-train service between London and the north. The system adopted was conceived by Sir Oliver Lodge and Dr. Alexander Muirhead, who are assisting the electrical engineer of the railway. The difficulty with the aerial wire constituted the greatest problem. In order to test the idea under the most disadvantageous conditions, an old car was used as a receiving station. The aerial wires were carried on porcelain insulators, the height of the wires varying from nine to fifteen inches above the curvature of the roof. From the roof the wires are carried in a small cable through a special insulated fitting to the interior of the van to the receiving instrument. Here the message is written by a Lodge-Muirhead syphon recorder. The transmitting station is situated in a hut near Derby, with an installation of apparatus for sending the message into the air. Outside the cabin is the aerial wire, which follows conventional lines, being supported upon masts forty feet from the ground and connected with a spark-gap and coil for increasing the strength of the electrical impulse discharged from the transmitting instruments at the station. The experimenters find the greatest difficulty is due to the large amount of electrical energy required to obtain successful conversation on account of the short aerial wire used at the receiving station.

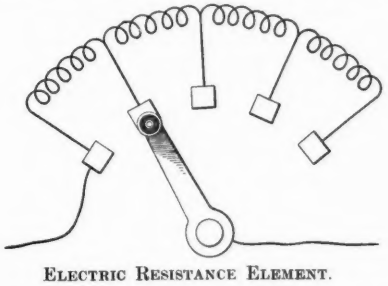
Electric Railway Statistics for Great Britain.

Some interesting statistics regarding electric railways in the United Kingdom (Great Britain and Ireland) are published in the London *Electrician*, February 2. The following is a brief summary of the present situation: there are 114 tramways supplied with power from combined lighting and traction stations. There are forty-seven tramways having their own power-houses, and there are ten electric railways in operation and five more under construction. In addition to the above there are nine tramways and light railways now being built, the particulars of which are included in the figures which follow. The figures show that the tendency to supply electric railways and lighting systems from the same power-house is still in favor.

The 114 combined stations supply 1,190 miles of road, or 1,860 miles of single track. The forty-seven tramways having their own power-houses have a mileage of 780, which is equivalent to 1,180 miles of single track. The first group of tramways operate 5,060 cars and the latter 4,360. The following statistics show the condition of the electric railway situation in England on January 1, 1905, which are interesting for comparison: there were 1,770 miles of road, equivalent to 2,740 miles of single track. On January 1, 1906, there were 1,970 miles of road, equivalent to 3,040 miles of single track, an increase of about eleven per cent in each case. At the beginning of 1905 there were 106 miles of electrically equipped railroad, equivalent to 212 miles of track. At the beginning of the present year there were 150 miles of road, or 285 miles of single track, an increase of forty-one and thirty-four per cent, respectively.

Electrical Patents.

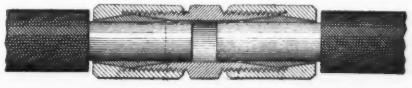
Albert L. Marsh, Lake Bluff, Ill., has obtained a patent (811,859, February 6) for an improved electric resistance element, assigning it to the Hoskins Company, Chicago, Ill. The object is to provide as an improved electric resistance material a metal which has the property of being particularly low in electric conductivity, has a melting point exceeding that of pure copper, and may be drawn or otherwise shaped to form particularly durable, efficient and desirable strips, strands or filaments, suitable for use in the various connections where electric resistances are desirable. It has been discovered that the metals of what is termed the "chromium group," particularly when mixed with nickel, form an alloy having the properties of being very low in electric conductivity, very infusible, non-oxidizable to a very high degree, tough and sufficiently ductile to permit drawing or shaping it into wire or strip form to render it convenient for use as an electric resistance element. The chromium group herein referred to, as defined, for example, in Watt's Dictionary of Chemistry, consists of the metallic elements of groups No. VI (indicated by the even-numbered series), according to what is generally designated as Mendeleeff's table. (See page 212, Remsen's Chemistry, fifth edition, Henry Holt & Company, New York, 1898). These metals are chromium, molybdenum, tungsten and uranium. Any one of these metals is suitable for the purpose, though for various reasons chromium is preferably employed. Uranium at the present time is so rare and expensive as to render its general use for this purpose commercially prohibitive. As the above metals possess characteristics in common which adapt them



Electric Resistance Element.

to this purpose, any one of them may be employed, though when alloyed with nickel or cobalt, for example, proportions may vary to produce the best electric resistances, taking into consideration the necessary toughness and degree of ductility desirable for the particular purpose in hand. For example, the inventor has found that an alloy consisting of ninety per cent nickel and ten per cent commercially pure chromium may be drawn into a fine wire and annealed, producing a tough metal having a melting point exceeding that of pure copper and with an electric resistance approximating that of pure copper. Its temperature coefficient is particularly low, it does not become crystalline and brittle under heating and cooling, it resists oxidation to a remarkable degree under very high temperature, and likewise keeps a polish under all atmospheric conditions, even where corrosive fumes are present.

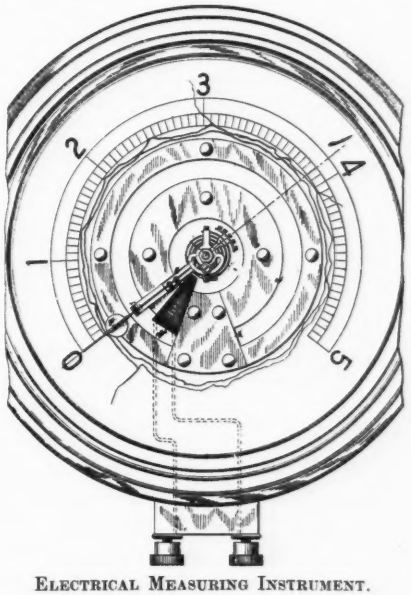
John J. Dossert, of New York, N. Y., has obtained a patent (811,906, February 6) for an improved electric coupling, as-



Electric Coupling.

signing it to Dossert & Company, of the same place. The object of the invention is a connection or coupler for solid wires or cables, adapted to join and form good electrical and mechanical connection for solid wires of the same diameter, solid wires of different diameters, cables of the same diameter, cables of different diameters, or solid wires and cables having the same or different diameters—that is to say, the coupling may form a satisfactory union for electrical conductors of whatever description and of different sizes if for any reason such a union should be desirable. Moreover, the coupling may unite a conductor of either type to an end or terminal connection without being necessarily confined to the joining of the ends of two continuous conducting wires or cables. The principle upon which the invention is based is that of using coupling members having tapering interior surfaces in combination with split cones adapted to be compressed inside the coupling members. The internal diameters of the coupling members will be varied according to the size of the wire or cable to which a given member is to be attached.

An improvement in electrical measuring instrument has been invented by Edwin E. Lehr, Wilkinsburg, Pa., and he has assigned it to the Westinghouse Electric and Manufacturing Co. (811,645, February 6). The invention relates to alternating current electrical measuring instruments and particularly to instruments of this general class which are employed for indicating the instantaneous values of the current in any given circuit, as distinguished from instruments which are employed for registering or recording the total amount of current or energy traversing a given circuit during a specific interval of time. The object of the invention is to provide an instrument of the character indicated which is simple, compact and inexpensive in construction and accurate in operation and the indicating member of which shall have a large arc of movement over a uniform scale. A further object of the invention is to provide an instrument which is adapted to accurately indicate the current in an alternating-current circuit in which it is connected, irrespective of a wave-form and frequency of alternations. The movable member or coil of this instrument constitutes the secondary winding of a series transformer, the currents therein being induced, utilizing the principle of the dynamometer and avoiding the use of mercury cups and all other forms of flexible connections to the movable member. The invention consists in the combination with a laminated iron core comprising two approximately annular portions located the one within the other and a substantially radial portion joining the same, of a stationary winding on one of the annular portions, a movable



Electrical Measuring Instrument.

coil closed upon itself and comprising one or more turns around the annular portion and adapted for movement about an axis coinciding with the axis of this portion, the plane of the coil being approximately radial to the centre of the core, means for opposing the movement of a movable coil, and means for indicating the degree of movement.

Reviews of Current Engineering and Scientific Literature.

The Hurzy System of Refloating Ships.

An ingenious method of raising sunk ships has recently been devised by M. Pierre Hurzy. The system depends upon the use of calcium carbide for setting free gas when brought in contact with water. At suitable points in the vessel cases of carbide are placed, which, when brought in contact with water, force out the latter, thus emptying the vessel. The method may also be used for emptying floats after they have been attached to the ship. The success of the method depends upon obtaining an equal buoyancy at the different parts of the vessel. For this purpose cans of carbide are placed at the points which are to be emptied of water. They are fitted with explosive caps, which are set off simultaneously by an electric current. In this way the case is ruptured, water is admitted, and the emptying of all compartments begins simultaneously. It is suggested also by the inventor that the method can be used to advantage in operating floating docks. After such a dock has been sunk and has taken in the vessel to be lifted the water is expelled from the ballast chambers by means of the acetylene gas set free from the carbide.—*Translated and abstracted from L'Électricien (Paris), February* 3.

The Up-to-Date Engineer.

After mentioning some of the requisites of a successful engineer, such as determination, energy and ambition, Mr. Ernest C. R. Deepholts discusses here what he believes to be the proper method of training the technical student, and he outlines such a course as conducted in one of the British government schools in the Far East. It is held that the young man should first get a good school education, and, by the time he is seventeen, enter a technical college. Here he must get a first-class practical and theoretical training, which should last from three to five years, and cover the fundamentals of engineering, including civil, electrical and mechanical. As conducted in the school mentioned, during the first year three hours a day are spent in a carpenter shop, the remainder in the lecture and classroom, where scientific and mathematical subjects are taught. The second year deals with more advanced physics and gives training in surveying and mechanical draughting, the construction of masonry walls, sinking of wells, building of bridges, etc., as well as practice in the blacksmith shop and foundry. During the third year practice in steam engines and applied mechanics, and advanced instruction in physics and electrical theory are given, while practice in general engineering is continued. On the completion of this year the students standing highest in the school are allowed to serve as helpers in the school's electrical plant, thus becoming familiar with the care and operation of gas engines, oil engines and steam engines, as well as electrical machinery. The requirements in the classroom are somewhat severe. Monthly examinations are given, at which a high percentage is required to pass. This covers theoretical as well as practical work. At the end of each year a thorough examination is given in all the studies for that year and for the preceding year. This examination lasts about three weeks and is a thorough test of the man's stamina and worth, as well as of his ability to review past subjects. During the student's training at this school he lives in quarters provided for him and is governed by strict regulations.—*Abstracted from the Electrical Review (London), February* 2.

A New Pyrometer.

M. Charles Féry, of Paris, has brought out a new type of pyrometer. The instrument, which is here described by M. E. Langlet, is in principle a thermoelectric pyrometer, but differs from other forms in the method of heating the couple. To form the couple a small iron and a small constantan wire are rolled out to form thin strips. The ends of the two strips are then joined together by a minute drop of solder. This couple is placed in a protecting case, and is heated by focusing upon it the image of the body whose temperature is to be measured. The image may be thrown upon the couple either by means of a reflecting mirror or a system of lenses. A good deal of care is necessary in working up the details of the apparatus in order to secure accurate results. The couple is coated with lampblack, so as to make it as nearly perfect as an absorber as possible. In the reflecting type of pyrometer this element is placed with its junction at the axis of a cylindrical case open at one end. The other end contains a concave reflecting mirror, which is formed of glass silvered on the outer surface. Such a mirror is nearly perfect as a reflector, but it has a slight objection, since the silver may be tarnished, particularly by sulphur gases. If the silvering be placed on the back of the mirror the glass introduces an error, since it is not perfectly transparent. Gold may be used for coating the mirror, but is objectionable on account of its selective reflecting action. To obtain accurate results it is necessary that the image of the hot body should be focused exactly upon the junction. To secure this the mirror is made adjustable along the case and is pierced at its centre so as to allow the junction to be inspected. The junction itself is placed between a pair of plane mirrors inclined to one another at an angle of about three degrees. Each of these mirrors, when viewed through the inspection opening, reflects the real image formed by the concave mirror, but, due to the angularity of the test mirrors, the two images coincide only when the real image is exactly at the intersection of the test mirrors, and hence focused on the junction. The apparatus may be calibrated in any way, and for values higher than those which can be accurately measured by the calibrating device a characteristic curve is constructed, which is formed by extrapolation by means of Stefen's law. To increase the range of the instrument it is fitted with a diaphragm consisting of two sections, each of which has two quadrants cut out. These sections can be slipped the one over the other, and in this way decrease the amount of radiation which enters the apparatus. The telescopic type of pyrometer makes use of a pair of lenses instead of the concave mirror. A similar method of focusing the image upon the couple is employed. For taking indications of this pyrometer a galvanometer of the D'Arsonval type is employed. The pyrometer itself is generally fitted with a small thermometer for making the necessary temperature correction, though generally these are negligible. This apparatus is suitable only for measuring the temperature of black body radiations, but since, in general, the substance whose temperature to be determined is within a furnace, it behaves as a black body. If, however, it be not under such conditions the instrument acts as a pyroscope, and not a pyrometer, but it gives concordant indications. In order to determine the temperature of selective radiations M. Féry has devised an absorption pyrometer. This resembles somewhat Weber's photometer,

since by means of a selective screen radiations of but a single wave-length are allowed to enter the device and fall upon a suitable screen. In another section of the instrument is a pyrometric standard, which is merely a small kerosene lamp. By an arrangement of lenses and mirrors two images are thrown upon the screen, one intersecting the other, and these are adjusted to equality by means of two tapering absorption screens, slipping the one over the other.—*Translated and abstracted from La Revue Électrique (Paris), January 30.*

Infra-Red Emission Spectra.

All the infra-red lines predicted by our spectral series formulæ end in the short wave-length just beyond the red. Any information as to the presence of lines beyond this point will aid in establishing these formulæ upon a firmer, less empirical, basis than they have at present. Such an investigation has been conducted by Mr. W. W. Coblentz, who has examined the infra-red spectra of solids and of certain compounds. Two methods are employed: the emission spectra of the electric arc struck between metallic electrodes and carbon electrodes, the chlorides of the alkali metals being introduced into the arc, in some instance, and the spectra of gases in vacuum tubes. The difficulty encountered when using the arc is the large amount of heat radiated relatively to the light radiation. The vacuum tube, on the other hand, radiates but little heat. For these reasons two exploring devices were required. A radiometer having a short period is necessary when employing the arc, so as to avoid errors due to the heating of the window and the consequent shifting of the zero reading. This device must have a short period, since the intensity of the radiation from the arc varies rapidly. When employing a vacuum tube the radiation is uniform and there is but little heat given out, but since the radiation is much less than that of the arc a more sensitive device is requisite. Work was begun by examining the spark spectra of metals like zinc, aluminum and copper. To examine the chlorides carbon electrodes, which had been hollowed out, the hollow being filled with compound, were used. The vacuum tube employed had electrodes of aluminum placed at right angles. It was connected to an air pump and had inserted a window of rock salt, through which the radiation passed. These tubes were filled with different gases. It was found that in working with the arc that the oxides of the metals give a strong black-body spectrum, which obliterates any emission lines, if such be present. Using the chlorides of the alkali metals, the strong emission lines mapped by Snow were verified, but no further ones could be found. With a vacuum tube the vapors of water and alcohol and the gases, hydrogen, nitrogen, ammonia, carbon monoxide and carbon dioxide were examined. Alcohol, carbon dioxide and carbon monoxide showed one strong emission band. Nitrogen gave three strong emission lines in the infra-red. These lines behave differently from those for the carbon gases. With a constant current the intensity of the carbon band increases with the pressure, but never reaches a maximum. On the other hand, the nitrogen bands increase in intensity with an increase in pressure, become a maximum with about two millimetres pressure and then decrease. At constant pressure all these lines increase with increase in current, as is true of the visible spectrum. Connecting condensers in parallel with the tube increase the intensity slightly, due to a corresponding increase in the tube. The emission spectrum of alcohol shows that a vapor in a vacuum tube can emit a continuous spectrum.—*Abstracted from the Physical Review (Lancaster), January.*

The Gas Producer Plant of a Modern Gas-Engine Station.

In a somewhat long discussion of the Oechelhauser gas engine, a detailed description is given of the gas-producing plant at the naval construction works at Dalmuir, England. At this place are located the works of William Beardmore & Company, Limited. The power-plant contains eight sets of gas engines, representing a total brake-horse-power of 4,800. Two of these engines are rated at 400 horse-power, two at 500, one at 1,000 and one at 2,000 horse-power. The last four are directly connected to generators and the first two directly connected to vertical air compressors. The electric power generated is distributed throughout the works for various purposes. There is not a single steam engine in the plant, though there are three boilers, which supply steam for operating the blowers, pumps, conveying machinery, and for the producers. At the present time, however, the exhaust from the pumps has given sufficient steam for the producers' requirements. All the machine tools and cranes are operated by electric motors, the electrical-generating plant being rated at 2,800 kilowatts. The hammers and forges and smithies are operated by compressed air on a regenerative system, the exhaust air being returned to the compressors. The furnaces for heating bars and plates are operated by gas from the producers, the mains for this purpose being carried through the works on built-up A-supports, which also carry the air pipes and electrical conductors. The entire arrangement of the plant has been so satisfactory that an extension is now being made, although the plant was laid out not more than two years ago. The producers are of the Duff type, each capable of gasifying one ton of coal per hour. They are charged mechanically, coal being tipped from the railway wagons into a large ten-ton hopper, where it passes through a breaker so as to reduce it to a uniform size. There are five producers, each fourteen feet inside diameter. They are lined with brick, reducing the dimensions to ten feet, six inches square. They are twenty-one feet, six inches high. A water lute is provided to enable the ashes to be drawn off without interfering with the working of the producers. The producers are spaced eighteen feet from centre to centre. The air blast is provided by two blowers, each capable of supplying 12,500 cubic feet of free air per minute at a water pressure of twenty-four inches. Each blower is sufficient for running all five producers. The air from the blowers is heated in a tower, down which flows the water formerly heated in the process of cooling the gas. Air at the same time takes up water vapor and becomes saturated. Exhaust steam is fed into the air main from this tower, and live steam can be provided if required. In the producers about three tons of steam and two and three-quarter tons of air are used in the combustion of each ton of coal. The air passes through a superheater before entering the producers. The gas, on leaving the producers, passes through a valve into the air-heating superheaters. Baffle plates are placed here to ensure that the air comes in contact with the entire tube surface. At this point the cleansing of the gas begins. There are pockets placed at stated intervals along the mains for collecting the soot and tar. A more important purification of the gas is carried out in the mechanical washer located in the producers. In this the gas is reduced to a temperature suitable for the recovery of ammonia, and is brought in contact with acidulated water, thus forming ammonia sulphate, which is recovered by crystallization. This is done by passing the air up through an acid tower, down which the water flows in a continuous shower. From this point the gas is carried to the different furnaces,, but is submitted to a further cleansing process before being used in the engines. This is done by passing it through sawdust scrubbers, which remove the last traces of tar. The engines are cooled by water supplied from a large tower.—*Abstracted from Engineering (London), February 2.*

Methods of Getting New Business.

A department devoted to the commercial development of Central Stations. Managers are invited to contribute suggestions for methods of increasing the demand for electric service.

The Fitchburg Gas and Electric Light Company, Fitchburg, Mass., is an example of the improvement accomplished through a systematic effort in the right direction after new business. The matter of selling current has been under the direction of Mr. A. H. Kimball, superintendent of the electrical department. Mr. Kimball's motto has been persistency with continual personal solicitation. The department has compiled some facts and figures of actual conditions which exist in the city, showing exactly what all the power customers are doing. A tabulated form is compiled every six months, giving the names of all the power customers, the horse-power in motors installed, the kilowatts used during the six months, the rate per year per horse-power installed and the average horse-power used, based on ten working hours per day, twenty-five days per month. The figures which are obtained in this way are extremely interesting, not only to the company, but also to the customers.

Until recently it was very hard to convince a customer that if his requirements called for a twenty-horse-power motor he would only have to pay for five or ten horse-power. The company's records show that beginning July 1, 1903, and compiling the statistics every six months to January 1, 1905, the percentage of horse-power used to horse-power installed was only twenty-five per cent. The actual figures were as follows: 24.28 per cent, 24.7 per cent and 25.5 per cent. This shows that the character of the power load was intermittent, and the customer averaged only a payment for twenty-five per cent of the actual power which he had installed.

Another point that has been very effective in talking to new customers is to show them the rate per hour per horse-power installed for electric power compared with what would be charged for the same amount of power taken from a steam plant. This analysis always showed rates very much in favor of the electric power.

After a customer's installation is started up the company makes a complete and detailed test showing his total friction load, total power load and also the individual friction and power load on each of the motors. This test the company has found is a great help to customers in showing them where a saving can be made by reducing their friction load. Some very surprising results have been obtained by comparing installations where motors were belted directly to the machines they were operating with installations in which lines of shafting with machines belted thereto were running.

On July 1, 1903, the company had in operation in Fitchburg 234 horse-power in motors. To-day the total is something over 1,500 horse-power, and the load is increasing very rapidly.

The accompanying tables which Mr. Kimball has very kindly supplied have been a great help in obtaining new business, as the prospective customer could be shown the actual results obtained by well-known concerns and individuals in the city; and presented conclusive evidence that electric power was both economical and satisfactory. In fact, the electric service has been so satisfactory that no customer has at any time made a change after once starting up an electrical equipment. In the accompanying tables the character of the shop is given, the names of the customers being withheld for obvious reasons.

SIX MONTHS TO JANUARY 1, 1905.

	Horse-Power in Motors.	Kilowatts Used Six Months.	Rate per Year per Horse-Power Installed.	Average Horse-Power Used.
Machine shop	12½	4,135	39.00	3.67
Printing office	½	65	43.20	0.058
Printing office	3	....	....	....
Coffee roaster	5	1,532	46.36	1.36
Grist mill	30	27,640	53.84	24.47
Printing office	1	265	49.68	0.235
Elevator	1	921	149.22	0.82
Broom shop	5	1,584	49.36	1.4
Horse clipper	2	....	....	....
Coffee grinder	2	121	21.60	0.1
Shoe shop	3	304	19.44	0.27
Wood yard	5	417	17.98	0.37
Machine shop	25	12,140	34.80	10.8
Machine shop	5	758	24.56	0.67
Cash system	2	1,185	89.00	1.05
Machine shop	8	2,988	48.68	2.65
Machine shop	5	582	22.60	0.517
Creamery	3	400	24.60	0.35
Printing office	10½	890	15.42	0.79
Cash system	1½	982	106.06	0.87
Jeweler	½	17	43.20	0.015
Printing office	2	103	21.60	0.09
Cotton yarn manufacturing	90	48,360	29.56	42.99
Leather store	5	158	17.28	0.14
Foundry	7½	2,812	48.60	2.5
Ice cream freezer	2	205	24.93	0.2
Optician	1	204	37.62	0.2
Tailor shop	1	260	48.24	0.23
Bindery	1	62	32.40	0.055
Printing company	15	5,474	39.10	4.87
Saw manufacturing company	142½	11,100	4.96	9.87
Saw manufacturing company	5	1,878	55.56	1.67
Wood yard	5	615	20.92	0.55
Coffee grinder	½	37	43.20	0.033
Sausage manufacturer	3	317	20.38	0.28
Carpenter shop	5	98	6.48	0.08
Printing office	3	702	41.62	0.625
Wood turning	42½	10,320	18.86	9.16
Coffee grinder	½	12	43.20	0.01
Coffee roaster	5	212	17.28	0.188
Brass foundry	3	196	18.00	0.174
Blower	5	....	....	....
Machine shop	2	102	21.60	0.09
Passenger elevator	15	6,200	40.92	5.51
Freight elevator	10	850	8.40	0.75
Elevator	9½	723	15.34	0.64

A comparison of the power used by two firms in this city doing the same class of work.

1905.	22-Horse-power Installed, Motor Direct Connected to Machines. Average Horse Power Used.	30-Horse Power Installed, Motors Belted to Shafting and Machines Belted from Same. 1905. Average Horse-Power Used.
May	1.9 "	13.22 "
June	3.9 "	14. "
July	2.4 "	11.84 "
August	4.03 "	11.89 "
September	3.6 "	11.04 "

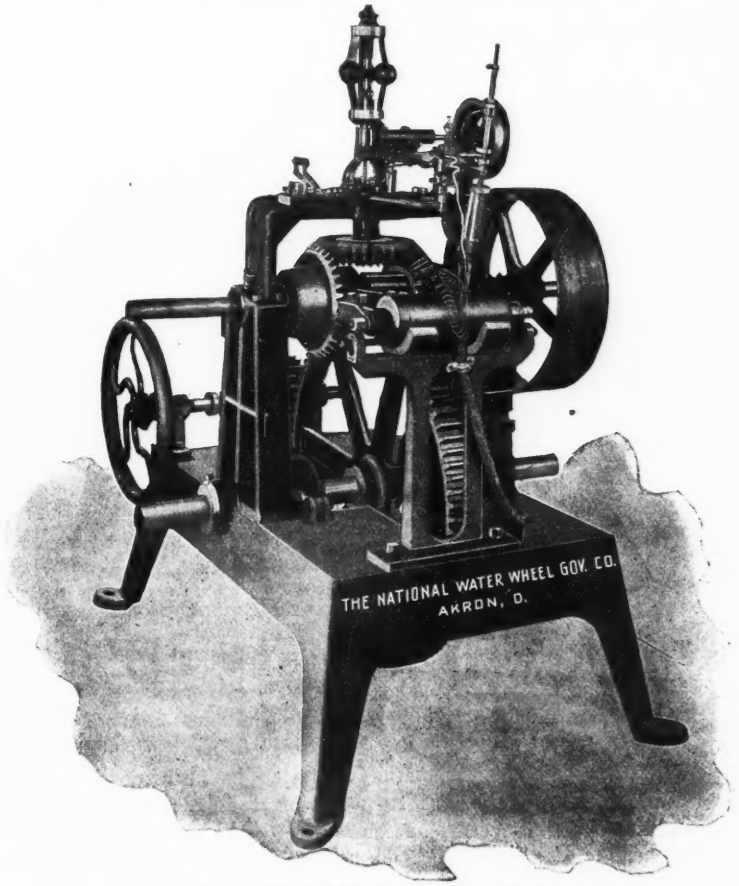
INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

A New Water-Wheel Governor.

The National Water-Wheel Governor Company, Akron, Ohio, has placed on the market a new type of water-wheel governor entirely eliminating pawls, ratchets, trips or slides in its construction.

The maker claims that the governor shown in the accompanying illustration is peculiarly fitted for the exacting requirements of water-wheel governing. As may be seen from the illustration, a double-ended cone clutch and two outer friction cones are mounted on the pulley shaft.



NEW TYPE WATER-WHEEL GOVERNOR.

One of these outer cones is keyed to the shaft and drives the other outer cone in a reverse direction by means of an idler gear. The gate movement is thus effected by pressing the cone against one or the other (as the case may be) of the outer clutches. The double-ended cone is spur-geared to the master gear, through which is passed the gate-moving shaft. Attachment can be made at either end of this shaft to the gate shafting. The driving pulley can rotate in either direction and can be placed on either end of its shaft.

A powerful electromagnet or solenoid plunger is attached to a fulcrumed lever, and this lever presses the cone clutch one way or the other to effect the movement of the gate. The governor is thus electrically tripped, giving practically an instantaneous response, as the outer clutches are in constant rotation. A quick-acting spring governor head operates a small lever, and this lever closes the circuit one way or the other, as the case may be. The electrical coil is properly encased or armored, and, if electricity is not convenient, the manufacturer is prepared to furnish a small dynamo which can be placed where desired.

The New Type Westinghouse Horizontal Double-Acting Gas Engine.

In the last issue of the ELECTRICAL REVIEW there appeared a brief description of the equipment of the Warren & Jamestown Street Railway. A feature of this installation is the adoption of the new type of horizontal double-acting gas engine built by the Westinghouse Machine Company. The builder has sought to construct a prime mover best suited from all standpoints to the American market—uncomplicated in design, simple to operate, substantial and permanent in construction, reliable in its working, and possessing the best economy compatible with the more necessary elements of simplicity. The resemblance to approved steam-engine practice is strong; in fact, the engine stands not as an example of radical change in structure but as an adaptation to gas working of the ample steam experience of the builder in Corliss engines. Symmetrical design has been adopted wherever possible, notably in the cylinder casting with its symmetrical valve chambers and in the pistons. A relay-governing system has been devised which has proven entirely adequate in respect to both regulation and parallel working. The absolute necessity of accessible parts has largely influenced the design of the engine and resulted in its elevation to such height that all parts are above floor level. Inspection and cleaning, especially of cylinders, is possible without dismantling the engine.

Possibility of injury from neglect has been avoided by providing automatic auxiliaries, both oil and cooling water being delivered under gravity head, cylinder oil by positive pressure and compressed air for starting from storage reservoirs. The starting arrangement has proven particularly efficient, and with only two operations, viz., opening of gas and air valves, the engine automatically starts and comes up to speed under its own ignition without further attention. On large engines considerably less than a minute is required to bring the engine up to speed, and, if desirable, a number of engines in a station may be simultaneously started from one point within this period of time. To ensure the greatest degree of reliability a duplicate system of igniters is employed with four different combinations in each combustion chamber. Any igniter may be replaced while the engine is in service, and in case of necessity any cylinder may be isolated for repairs during operation.

The Beau de Rochas or four-stroke cycle is used, which, with the tandem arrangement, gives a power impulse with each successive stroke of the engine. Cylinders are

twenty-one inches in diameter by thirty-inch stroke, the unit running at a nominal speed of 150 revolutions per minute.

The cylinders are symmetrical about both axes, supported free from foundations by front, centre and rear housings. Front housings are anchored; the remainder of engine is free to adjust itself to temperature changes. Jacket walls are cast free; the interior of cylinders are accessible from above and below through valve openings without removing heads.

The crank shaft is solid forged steel, with positive pressure oiling at pin.

The bearings are of segmental construction, wedge adjusted, with water-cooled shells.

The crossheads are of cast steel, with bored guides and adjustable slippers.

The pistons are in one piece, cast symmetrically about both axes without internal ribs and mounted permanently on the piston rod. They are water-cooled and floated free from the cylinder walls.

The piston rods are of nickel steel with bored water duct, made in two parts to facilitate handling and united at centre crosshead. The rear piston may be disconnected.

The packing is of the segmental metallic type, floating about rod and internally lubricated.

The valves are all steel of the poppet type, spring-seated in direction of pressure and removable in one piece with bonnet.

There is one inlet valve for each cylinder end, combining the functions of mixing, governing and admission. Each valve is under direct governor control.

The exhaust valve is raised by a multiplying lever system giving heavy force at start, followed by rapid opening. These valves are water-cooled and always full of water.

A balanced relay system of governing is used, an auxiliary oil cylinder doing all work of actuating the main valve. There is a sensitive centrifugal regulator positively driven; likewise an auxiliary oil pump supplying the relay system. The governing equipment includes a manual synchronizing adjustment for alternating-current working.

The ignition is of the hammer-break type, in duplicate, with two independent sources of current. The point of ignition is changeable and the igniter plugs removable while the engine is running, and there is an automatic safety stop interposed in the igniter circuits.

The circulation includes separate water circuits for each important part, with open funnel discharge. The pistons are maintained at even temperatures by a double-ended plunger pump attached to the centre crosshead. There is a gravity water supply for the entire engine, with an automatic motor-driven pump for maintaining constant head.

The oiling system includes a gravity flush system for engine oil with filter and positive-driven return pump. For cylinder oil there is a positive timed injection from sight-feed pumps driven by the engine.

Electric Hoisting Machinery.

The Crocker-Wheeler Company, Ampere, N. J., has designed a number of applications of electric motors to the driving of hoisting machinery. Within the past few years the use of electric motors for operating all classes of hoisting machinery has greatly increased. This is especially due to the adaptability of motors for this purpose. The advantage of being able to dispense with a boiler in the case of a steam-driven hoist, or a compressor, in the case of the pneumatic hoist, rendering the machinery easier to transport and subject to less attendance, is being clearly recognized by many interests who are eager to adopt an economical hoisting process.

Electric hoists are effectively employed on wharves and docks for coaling and for loading and discharging freights and cargoes. They are also used for handling all kinds of merchandise in warehouses. The drum hoist provided with a winch head is of great assistance on shipboard, the drum being used for handling cargoes, as well as boats, while the winch head is used for warping the ship into the dock or for changing its position along the wharf.

Fig. 1 shows a Crocker-Wheeler standard electric hoist. This hoist is provided with a winding drum driven by a motor through a double run of spur gearing. The drum is free to revolve on the shaft, but is thrown into engagement with the gearing by means of a friction clutch operated by a hand lever. When the drum is disengaged from the clutch its motion may be regulated or stopped by means of a band brake operated by a foot lever. This lever is counter-balanced, so that the brake is instantly released as soon as the foot is removed from the lever.

The motor is operated by a reversible drum controller providing twelve or more speeds in both directions. The location of the controller handle, foot lever and friction clutch is such as to place them all within easy reach of the operator. The motor is of the fully enclosed type with a compound winding especially suited to this class of work.

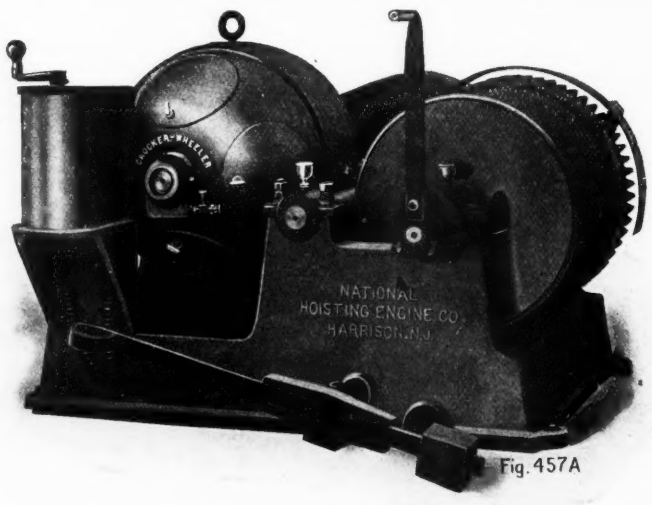


FIG. 1.—CROCKER-WHEELER STANDARD ELECTRIC HOIST.

In operation the motor may be run continuously and the motion of the drum controlled by means of the friction clutch and band brake; or, when the class of service demands, the friction clutch may be engaged and the motion of the drum regulated by the controller.

The average rope-speed of these hoists ranges from 150 to 200 feet per minute, the weight of load ranging from 800 pounds to 4,500 pounds.

Fig. 2 shows the Crocker-Wheeler standard electric winch. This machine is designed to carry two winch heads, one being mounted on each side of the machine shaft. The heads are keyed to this shaft and the drive from the motor is through a double run of spur gearing. The winch heads are ribbed so as to provide a secure hold on the rope and a fric-

tion band brake is applied to the side of the gear upon the main shaft. This brake is controlled by two levers, so that it may be operated from each side of the winch.

The motor equipment and controller are the same as are furnished with the standard hoists, but the controller in this case is placed at the rear, so that the operator, when he stands at the controller, is able to handle a rope coming from either winch head. In operation the motor may be run continuously, or its speed may be regulated as desired by means of the drum controller. The average rope-speeds of these winches range from 130 to 135 feet per minute, the weight of load ranging from 1,000 pounds to 7,000 pounds.

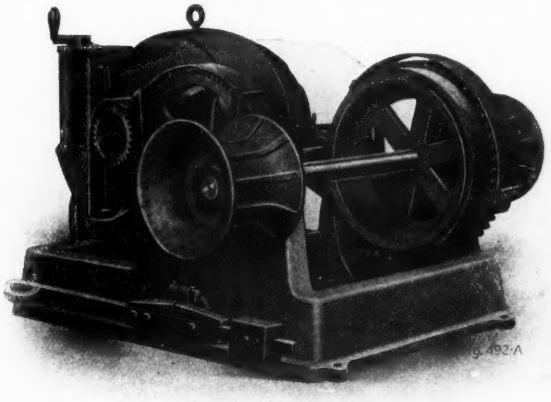


FIG. 2.—CROCKER-WHEELER STANDARD ELECTRIC WINCH.

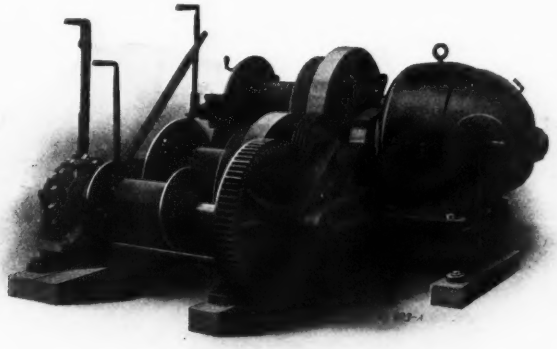


FIG. 3.—MOTOR-DRIVEN, DOUBLE-DRUM HOIST.

Fig. 3 shows a motor operating a double-drum hoist, built by the National Hoisting Engine Company. These double-drum hoists may be furnished in sizes from seven and one-half to thirty-five horse-power. The hoists are especially designed for boom derrick work, having two drums, one for raising and lowering the boom and the other for handling the load. This hoist has also a reversible boom-swinging drum. The hoisting drums are provided with shrouded ratchets and pawls of ample strength to hold securely any load within the capacity of the hoist. The swinging drum is so arranged that there can be no fouling of the lines, since they are always under uniform tension, one unwinding while the other is winding up.

The motor equipment of this hoist is the same as has been described for the single-drum hoists. This machine may also be provided with winch heads mounted on the outer end of the drum shafts. It is also supplied with or without the boom-swinging drum, as desired.

Hydroelectric Elevator in Tudor Apartment Building, Chicago.

The accompanying views illustrate the electrically driven hydraulic machinery for operating the passenger elevator of the Tudor building, a five-story apartment house situated at the corner of Forty-third street and Ellis avenue, Chicago, Ill. The plant constitutes a most interesting application of the induction motor to the operation of hydraulic passenger elevators.

Referring to the accompanying illustration, Fig. 1, the motor is a fifteen-horse-power, 220-volt General Electric Company's form K induction motor, taking current from the mains of the Commonwealth Electric Company, and is provided with a special high-resistance rotor in order that the starting current may not attain a high enough value to interfere with the voltage regulation of the supply circuit. The motor is belted to an 8 by 10 vertical single-acting triplex pump, which discharges into a compression tank against an average pressure of eighty pounds per square inch, thereby providing the necessary hydraulic power for operating the elevator.

At the right in Fig. 1 may be seen the weight lever and weight of a Mason regulator which starts and stops the motor through the instrumentality of a form I oil switch. Fig. 2 clearly shows this controlling apparatus. It will be seen that the operating lever of the regulator is connected to the lever of the oil switch. The spring attachment, with which the oil switch is ordinarily equipped in order to give a quick break, was removed, as the motion of the Mason regulator is positive and gives a speed of about eight inches per second at the operating lever.

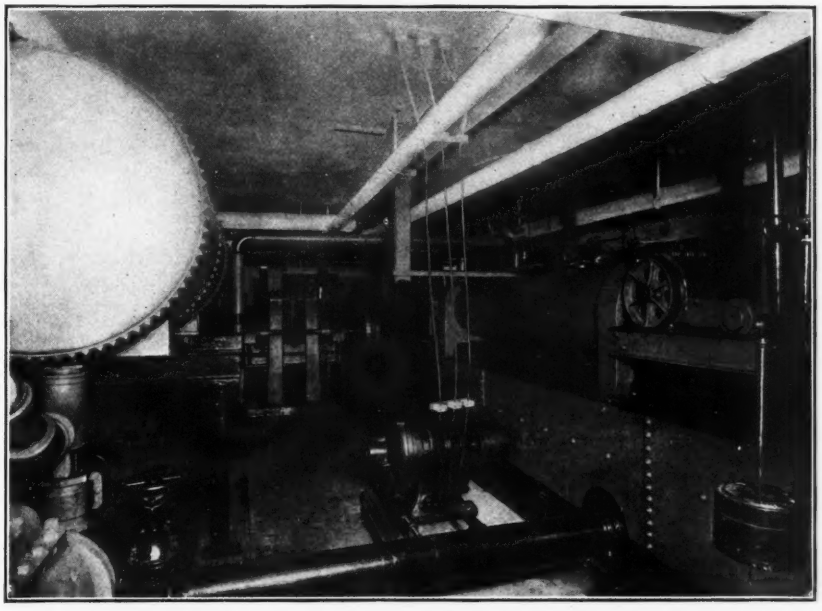


FIG. 1.—INDUCTION MOTOR BELTED TO TRIPLEX PUMP FOR OPERATING HYDRAULIC ELEVATOR.

When this controlling apparatus was first installed the regulator was set to start

the motor when the pressure fell to seventy pounds and to stop the motor when the pressure rose to eighty-five pounds. Later it was found that a pressure of thirty-five pounds was sufficient to operate the elevator with average load. The adjustment of the regulator was accordingly changed so as to start and stop the motor less frequently, thus giving longer periods of work and rest. With the motor shut down after having brought the pressure to the maximum, the elevator makes three average trips before the pressure falls to the point at which the regulator operates to start the motor. It takes about three minutes after the motor is started to bring the pressure back to the maximum, and the motor delivers thirteen and one-half horse-power when operating against the maximum pressure.

Notable features of this installation are its simplicity and the fact that it utilizes standard apparatus; the only special features being the omission of the quick-break spring from the oil switch and the substitution of a high-resistance rotor in the otherwise standard induction motor.

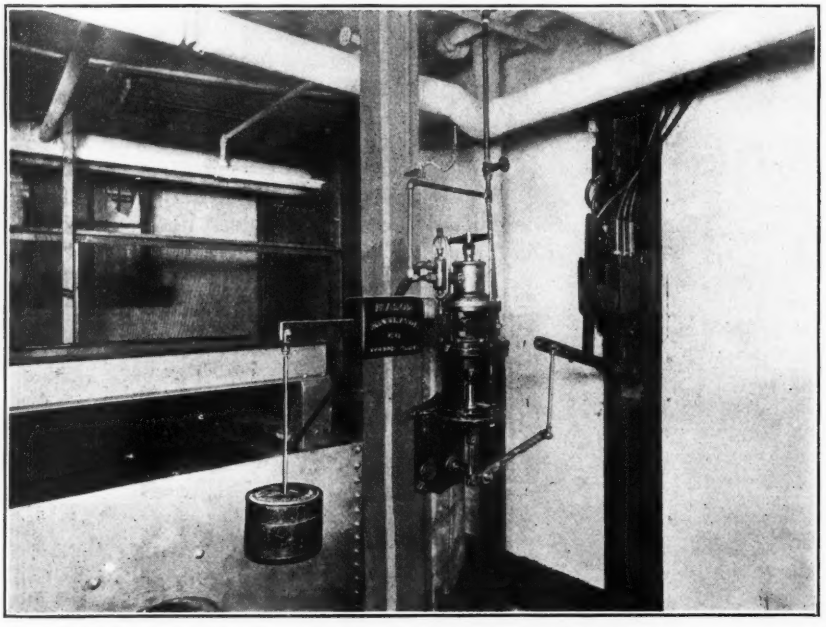


FIG. 2.—REGULATOR OPERATING OIL SWITCH, HYDROELECTRIC ELEVATOR INSTALLATION.

The installation was put into service about the first of June of last year and has been operated continuously ever since, with very little attention and with no expense except for current, which is costing the owner $40 per month, at ten cents per kilowatt-hour. The previous cost of operating (with steam) was $95 per month for fuel and $35 per month for night engineer, a total of $130 per month.

There are undoubtedly many similar cases where elevators can be operated more economically and satisfactorily by the above-described method—an induction motor-driven hydraulic elevator machinery—than by other methods of electric drive.

Iron-Clad Cabinets.

The Troy Electrical Company, 1924 Sixth street, Troy, N. Y., has placed on the market a line of iron-clad electrical specialties. Fig. 1 shows an iron-clad New Code standard underwriters' enclosed fuse cutout. This cutout is made in sizes from one ampere to thirty amperes; thirty-one amperes to sixty amperes with the New Code ferrule contact. From sixty-one amperes to 600 amperes the cutouts are made in the standard New Code knife-blade contact.

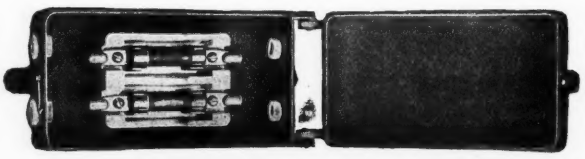


FIG. 1.—IRON-CLAD ENCLOSED FUSE CUTOUT.

Fig. 2 shows a New Code iron-clad underwriters' standard cutout and switch cabinet in sizes from one to thirty amperes. With this type the branches leave from the top and bottom of the cabinet and the mains enter through the side. Fig. 3 shows a similar type made with either two or three-wire mains, with the branches leaving the sides, the mains entering from either the top or the bottom. Fig. 4 shows the iron-clad New Code standard entrance switch, which is made up in the plug-fused combination type up to thirty amperes, and up to sixty amperes in the New Code enclosed fused ferrule-contact type. From sixty-one amperes to 600 amperes this entrance switch is made up with the enclosed fuse standard knife-blade contact, either single-pole, double-pole, three or four-pole.

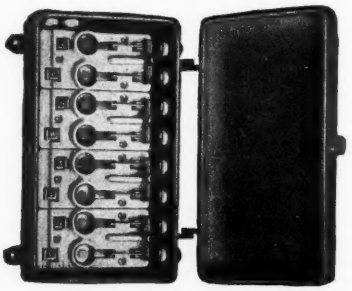


FIG. 2.—IRON-CLAD CUTOUT AND SWITCH CABINET.

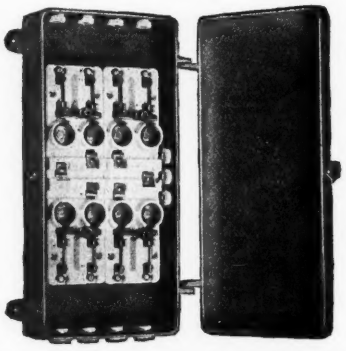


FIG. 3.—IRON-CLAD CUTOUT AND SWITCH CABINET.

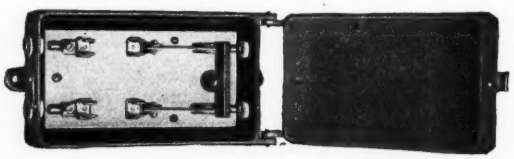
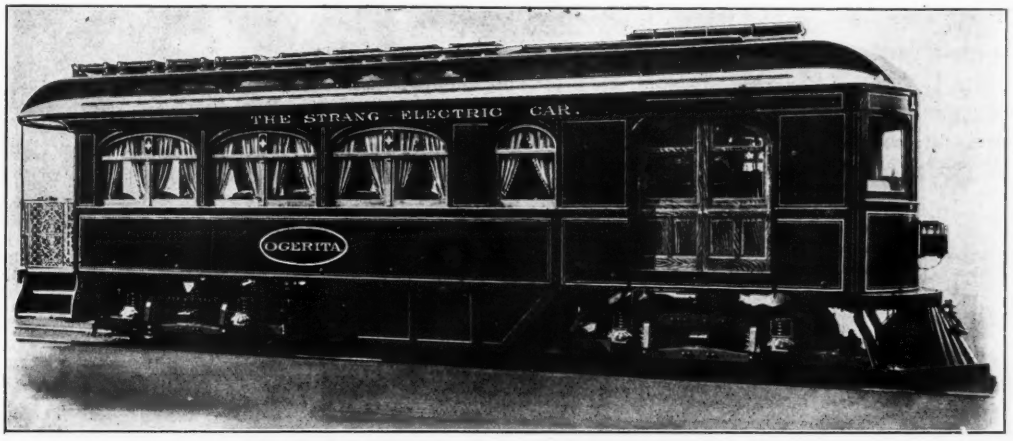


FIG. 4.—IRON-CLAD ENTRANCE SWITCH.

A Gasoline-Electric Car.

Within the last few years a great deal of attention has been paid to the electric omnibus and the gasoline-electric car. Quite recently a gasoline-electric car, built by the Strang Electric Railway Car Company, of New York city, left New York for a trip to San Francisco *via* the West Shore, New York Central, Michigan Southern, Rock Island, St. Louis & San Francisco, and Southern Pacific railroads. The car, which is of special construction, was built by the J. G. Brill Company, Philadelphia, Pa. The Brill company is building several more cars of the same type, each of which will measure fifty-two feet nine inches over the vestibule. These cars have smoking and passenger compartments, and are mounted on high-speed trucks of the Brill No. 27-E type.



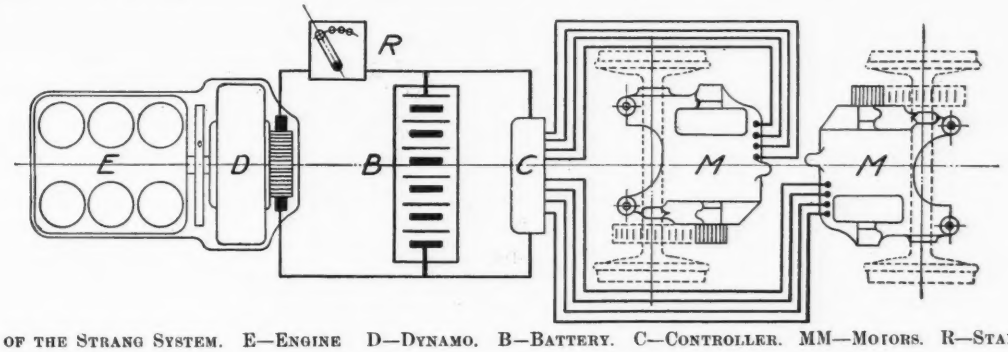
GASOLINE-ELECTRIC CAR.

The advantage of the Strang system is that it requires an engine only large enough to develop the average power used. The engine was designed by Lars G. Nilson, chief engineer of the Strang Electric Railway Car Company, the builder. The engine is of the four-cycle type, and has six eight-inch by ten-inch cylinders. To secure a short crank shaft and reduce vibration to a minimum, the cylinders are partially opposed, three on each side, and are set at an angle of ninety degrees to each other. The engine frame is a substantial cast-steel structure, securely bolted to a rectangular base of the same metal. The weight of the entire engine is reduced by using aluminum for covering parts where there is no strain. Kerosene, alcohol or crude oil may be used instead of gasoline, with a slight change of adjustment of the vaporizer. High-tension or jump-spark ignition is used. The oil is contained in a reservoir placed beside the base of the engine, and is pumped to the different bearings, being returned to a filter located over the reservoir after use. A centrifugal pump, belted to the flywheel, draws water from a tank in the vestibule at the centre of the car and forces it through the cylinder jackets and to radiating pipes upon the roof. In cold weather the passenger compartment is heated by the water from the cylinder jackets. The gasoline is stored in safety tanks underneath the car floor, and is pumped to an overflow cup at the side of the vaporizer, the excess being returned to the tank by another pipe. The cells of the storage battery are placed on a cradle underneath the centre of the car.

The electrical equipment consists of a fifty-kilowatt, 250-volt, direct-current generator, directly coupled to the gasoline engine; two fifty-horse-power, series-wound motors of the regular street railway type; two K-13 controllers and a storage battery of 112 cells having 200-ampere-hours capacity.

For running on a level track under ordinary conditions the current goes directly from the generator to the motors, but when coasting down grade, slowing-up or standing still, the surplus current is taken up by the batteries, furnishing the extra power necessary for acceleration and for ascending steep grades. This arrangement is entirely automatic.

The switchboard is placed against the left side of the engine compartment within easy reach of the operator. It includes a voltmeter, ammeter, starting rheostat and spark control. The platform at the rear of the car is equipped with a controller and a combination volt and ammeter.



GENERAL PLAN OF THE STRANG SYSTEM. E—ENGINE D—DYNAMO. B—BATTERY. C—CONTROLLER. MM—MOTORS. R—STARTING RHEOSTAT.

The maximum speed of the car is fifty miles per hour. The average gasoline consumption is 0.45 gallon per car-mile. One hundred gallons of gasoline are carried, which gives a radius of 225 miles.

Insulating Material.

The Clark Electric and Manufacturing Company, 26 Cortlandt street, New York city, has placed on the market an extensive line of insulating devices, some of these possessing features of more than ordinary merit.

Fig. 1 shows a Clark standard insulator clamp. This clamp is designed for use with standard insulators. The two clamps are tightened firmly to the conductor on each side of the insulator by means of the bolt and nut. The projecting lips engaging the grooves of the insulator transfer the end strain to the porcelain in an effective manner. The loops surrounding the neck of the insulator hold the clamps in position and prevent the conductor from being lifted from the groove.

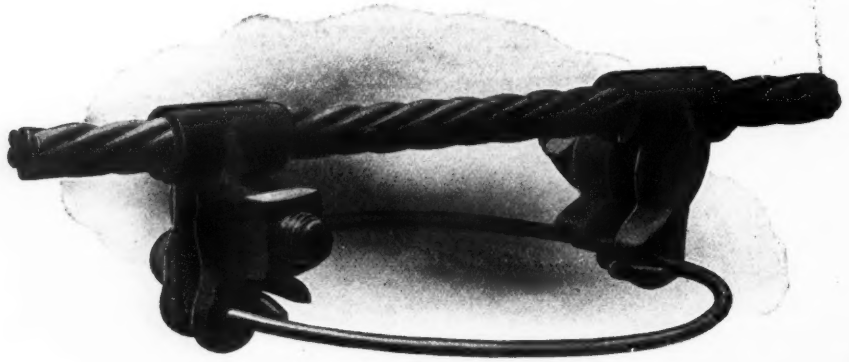


FIG. 1.—CLARK STANDARD INSULATOR CLAMP.

Fig. 2 shows the type A angle-locking insulator clamp. This clamp is designed to clamp firmly upon the transmission conductor with two stud bolts and nuts, the angle of the clamp fitting into an angular recess in the porcelain insulator below and around the groove of the insulator. One clamp is used on each side of the insulator in such a position on the conductor as to prevent it from being lifted from the insulator, but permitting either a vertical or horizontal swing being transmitted from one span to the next without throwing undue strain upon the conductor.

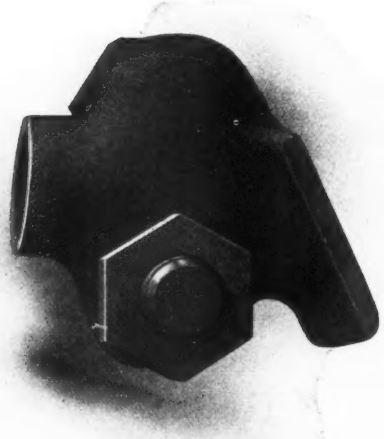


FIG. 2.—ANGLE-LOCKING INSULATOR CLAMP.

Fig. 3 shows a type A interlocking insulator clamp. This clamp is designed to hold the cable or transmission conductor in the groove of the insulator. The insulator is constructed with an under-cut recess on each side of the groove in the centre of the insulator top, so that when the clamp is in position it is interlocked under the projecting portion in such a manner that the wire can not be removed or the clamp separated from the insulator without unlocking the clamp.

The construction is such that the end strain on the clamp is distributed so that excessive pressure will not be concentrated on a small area of the porcelain. At the same time sufficient clearance is allowed so that the cable and clamp may move freely when the cable or conductor is in place in the insulator.

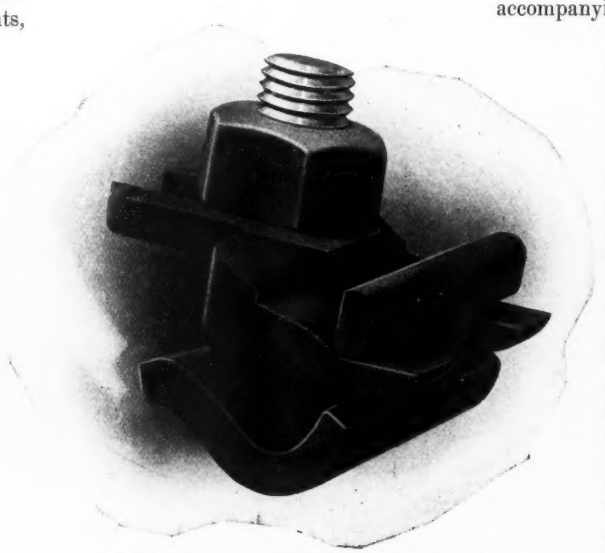


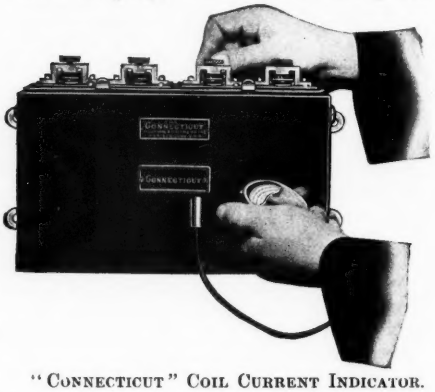
FIG. 3.—INTERLOCKING INSULATOR CLAMP.

FIG. 4.—POSITION OF INTERLOCKING CLAMP ON INSULATOR.

Fig. 4 shows the position of the clamp in the insulator.

A New Coil Current Indicator.

The Connecticut Telephone and Electric Company, Meriden, Ct., has placed on the market a coil current indicator, the application of which is shown in the accompanying illustration. This device consists of a special form of indicating meter, attached to which is a double conducting cord and metallic circuit plug. With this instrument it is possible at any time to see just how much current is being drawn from the battery. In operating, the running plug is removed and the metallic plug attached to the meter is pushed into the jack from which the running plug has been removed. This throws the instrument into circuit and indicates the amount of current passing through the coil. The application of this device will result, in many cases, in the cutting down of the amount of current used for firing the charge. Increasing the tension of the vibrator increases the amount of current passing, and often there is more current used than is necessary.



"CONNECTICUT" COIL CURRENT INDICATOR.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

FOR MILWAUKEE (WIS.) CITY LIGHTING PLANT—Mayor Rose, Milwaukee, Wis., on February 7 signed the ordinance passed by the council providing for the issue of $150,000 in bonds to pay for a site and other preliminaries for a municipal lighting plant.

CHICAGO TELEPHONE COMPANY RECEIVES SETBACK FROM SUPREME COURT—The Illinois Supreme Court has rendered an opinion upholding the 1889 ordinance, making the Chicago Telephone Company amenable for $500,000 in excess charges suits, and indicates a further possible $500,000 owing to the city for compensation. The opinion also makes the rates on business telephones $125 a year, instead of $175 as previously charged.

CALIFORNIA POWER COMPANIES CONSOLIDATE—The Stanislaus Electric Power Company and the Tuolumne County Water and Electric Power Company have been consolidated and it is understood that the interests concerned in the consolidation will build a new $10,000,000 plant in the near future. The properties which have been acquired are of considerable extent on the Stanislaus river and on the Tuolumne river, together with more than 180 miles of ditches conveying water from the streams.

CUMBERLAND TELEPHONE COMPANY INCREASES ITS CAPITAL—At a meeting of the stockholders of the Cumberland Telephone Company, held at Hopkinsville, Ky., February 1, an increase of $3,300,000 in the capital stock was voted. This increase makes the company's capitalization $17,000,000. The proceeds of the new issue of stock will be used for extensions to the system. Each of the stockholders will be allowed to purchase at par an amount of new stock not to exceed twenty-five per cent of his present holdings. The company is preparing to build at Nashville, Tenn., a plant for the manufacture of everything used in the system.

LARGE POWER PLANT PLANNED FOR HELENA, MONT.—A second dam is being built across the Missouri river near Helena to back up the water and form a lake several miles in width. It is purposed to build a second plant similar to that now operated by the Helena Power Transmission Company. Four large induction motors have been ordered for the 10,000-ton concentrator of the Washoe company at Anaconda, and these will be operated by power furnished by the electrical company. Power is to be transmitted about one hundred miles at 70,000 volts.

NEW IDAHO ELECTRIC LINE—The Salmon River Power Company and the Central Idaho Development Company were incorporated February 7 at Lewiston, Idaho. The first-named company will furnish power for the Lewiston-Grangeville electric line and the latter company will act as the holding company which is to build the road as well as the power plant. The capital of the power company is $2,000,000 and of the development company $250,000. The incorporators, who are the same for both companies, are G. W. Thompson, T. S. Ward, John McCormack and F. J. Randolph, of Lewiston; J. A. Crom, Westlake; Robert H. Jones, Grangeville; and A. C. Eitzen, Nez Perce.

MARYLAND TELEPHONE COMPANY CAN CHARGE HIGHER RATE—The Court of Appeals has handed down an opinion in the case of the Charles Simon's Sons Company against the Maryland Telephone Company, giving the telephone company the right to increase its rates. The suit was brought by the Charles Simon's Sons Company as a result of the Maryland Telephone Company's increasing its rates after they had been fixed by city ordinance. It was contended at the time, on behalf of the telephone company, that the cost of service had greatly increased and that the service was superior to that given at the time of the passage of the ordinance. Last summer an opinion was handed down by Judge Harlan in the Circuit Court, in which the suit was brought, upholding the contention of the subscribers of the company, that the company could not charge more than the prices fixed by ordinance.

MERGER OF MICHIGAN LIGHTING AND POWER COMPANIES—The North American Company is planning a merger of industrial interests involving the greater number of all the power and lighting plants in the southeastern part of Michigan. The various links in the combination are said to be as follows: the Detroit Edison Company, the Central Heating Company, Detroit; the Ypsilanti power plant, the Grasse Point plant, the Ann Arbor power plant, power plants at Port Huron, Pontiac, Kalamazoo and Jackson. It is said to be part of the scheme to erect a large dam at Ann Arbor, to form a chain of lakes five miles in length, and a parkway along the Huron river. The North American Company controls the Detroit Edison Company and recently purchased the Ypsilanti power plant. The company has brought the Grasse Point plant and is negotiating now for the purchase of the Pontiac power plant.

TO UTILIZE UPPER NEW YORK WATERSHED FOR ELECTRIC POWER—The report of Wallace C. Johnson, engineer member of the New York state river improvement commission, states that a series of reservoirs could be constructed in the vicinity of Albany, Troy and Rensselaer, N. Y., and effect a total reservoir capacity of 54,000,000,000 cubic feet. The spring floods, so destructive along the Hudson and Mohawk river valleys, could be controlled by the construction of a system of water storage reservoirs, and these reservoirs could be utilized in generating electric power, the sale of which, it is believed, would be ample to meet the expense of establishing the reservoirs and afford an income at the same time. The present commission is composed of Attorney-General Mayer as president, State Engineer and Surveyor H. A. Van Alstyne, Superintendent of Public Works N. V. Franchot, Forest, Fish and Game Commissioner James Whipple and Wallace C. Johnson.

SALTILLO, MEXICO, ELECTRIC LIGHT AND POWER PLANT—A proposition is under way to furnish Saltillo, Mexico, with an electric light and power plant in the near future. The waterfall near Arteaga, a small village near Saltillo, is to be utilized, and unless unforeseen delays occur, actual construction will be started shortly. Preliminary surveys have already been made. The lighting system in Saltillo was up to a short time ago adequate for the needs of the town, but with the growth of the city and the establishment of new business houses it has been decided that a new company could find many customers. Mr. Alfred Lilliendahl has secured valuable concessions from the government and has interested northern capitalists in the undertaking. If the new plant proves successful an electric car line will probably be established between Saltillo and Arteaga. The line would pass the cotton factories at Aurora and La Libertad, getting all the traffic from these settlements as well as from the ranches and hamlets in the neighborhood.

LOWER TELEPHONE RATES IN EXCHANGE FOR NEW FRANCHISE IN CHICAGO—The Chicago Telephone Company has submitted a new schedule to the council committee on gas, oil and electric light for the city of Chicago. The company's franchise expires in three years, and in return for reduced rates the corporation demands a twenty-year extension of its agreement with the city. The company will, it is said, abolish all toll charges within the corporate limits of Chicago and make the Chicago exchange coextensive with the existing city boundary lines. The company will be required, under the agreement, to pay three per cent of its annual gross receipts to the city. The officers informed the committee that under the proposed agreement the company will be put to an expense of $15,000,000 to make the necessary extensions and improvements required for effective public service. General Manager Hibbard stated that the company was considering the plan of abolishing all toll lines within the city limits and connecting all lines with the Chicago exchange.

TELEPHONE AND TELEGRAPH.

OMAHA, NEB.—The Nebraska Telephone Company will establish a plant at Florence.

OAKLAND, CAL.—The Sunset Telephone Company will improve its service at West Berkeley.

SOLEBURY, PA.—The Bell Telephone Company is extending its line from New Hope to Centre Hill.

WEBSTER CITY, IOWA—The Martin Telephone Company has completed a local circuit to Waterloo.

READING, PA.—The Conestoga Telephone Company is extending its lines to Stonersville and Yellow House.

STERLING, ILL.—The Interstate Telephone Company will expend about $10,000 in the spring, laying new cables and replacing old ones.

ROCKAWAY BEACH, L. I., N. Y.—The New York & New Jersey Telephone Company will erect a central exchange at Rockaway Beach.

BURLINGTON, IOWA—The Iowa Telephone Company has secured a site upon which it will erect a two-story exchange in the spring.

ONEIDA, N. Y.—A franchise has been granted the Central New York Telephone Company to place its wires underground in the business portion of Oneida.

LORAIN, OHIO—Officers of the Bell Telephone Company are making preparations to begin the operation of a local system, for which a franchise was received nearly a year ago.

BUTTE, MONT.—The Rocky Mountain Bell Telephone Company has decided to build a line from Missoula to Kalispell, and is contemplating an extension from Billings to Miles.

ATTICA, N. Y.—Work has been commenced at Alexander village in the construction of a telephone system, under the franchise recently granted the Inter-Ocean Telephone Company.

OAKLAND, CAL.—The mayor of Oakland has approved the ordinance granting a franchise to the Home Telephone Company, of Alameda county, for a complete system in Oakland.

EDWALL, WASH.—The Colville Road Telephone Company has elected the following officers: M. Brislawn, president; J. J. Brown, secretary; Peter McGough, treasurer. The company will erect a line from Sprague to Edwall.

NASHVILLE, ILL.—The Addieville Progressive Telephone Company has elected the following officers: president, L. W. Kokesh, of Elkhorn; secretary, C. N. Rountree, of Elkhorn; treasurer, Emil D. Garlich, of Plum Hill; director, C. N. Rountree, of Elkhorn.

TROY, N. Y.—The Hudson River Telephone Company is said to have secured the lease of telephone lines in the northern part of the Adirondacks, north of Warrensburg, owned by William Rooney, which the Commercial Union Company has been leasing.

KANSAS CITY, MO.—Several farmers, living south of Oak Grove, have organized a telephone company, which is to be operated on the mutual plan. It will be known as the Round Prairie Telephone system. The line will connect with others at Lone Jack and Oak Grove.

JACKSONVILLE, FLA.—E. A. White, of Punta Gorda, Fla., has contracted with the Alafia, Manatee & Gulf Coast Railway Company to construct a telephone and telegraph line from Liverpool to Boca Grande, with a branch from Charlotte Harbor to headquarters in Punta Gorda.

CLARKSVILLE, TENN.—At a meeting of the board of directors of the Clarksville Home Telephone Company officers were elected as follows: Dancey Fort, president and general counsel; B. F. Gill, vice-president; W. E. Beach, treasurer, and H. M. Perry, secretary and general manager.

CLEVELAND, OHIO—At the annual meeting of the Cuyahoga Telephone Company the only change made in the board was the substitution of the name of B. Mahler for that of C. A. Otis. The board afterward organized by the election of the following officers: president, Frederick S. Dickson; vice-president, H. A. Everett; secretary, W. L. Cary; treasurer, R. W. Judd.

PHILADELPHIA, PA.—The Bell Telephone Company has opened its new Lombard exchange at Fourth and Manning streets, and 2,000 subscribers have been transferred there from the Market exchange. The new office was made necessary by the pressure of business on the Market exchange.

WICHITA, KAN.—The Missouri & Kansas Telephone Company will spend between $200,000 and $250,000 in improvements during the coming spring and summer. The improvements will consist in rebuilding the entire plant. An underground system will be installed and all the lines in the business district will be run in conduits.

ALBION, N. Y.—The Lakeside Telephone Company has elected the following directors: W. A. Tuttle, F. B. Conde, P. B. Wilson, S. A. Coe, George R. Fuller, C. M. Beattie, of Rochester, and T. S. Lane, of Jamestown. The officers are: president, G. R. Fuller; vice-president, W. A. Tuttle; treasurer, C. M. Beattie; secretary, S. A. Coe. The company has consolidated with the Rochester company.

NASHVILLE, TENN.—At the annual meeting of the directors of the Cumberland Telephone Company the following officers were elected: president, James E. Caldwell; vice-presidents, W. W. Berry and William Litterer; general manager, Leland Hume; treasurer, T. D. Webb; assistant treasurer, George R. Knox, Jr.; secretary, John W. Hunter, Jr.; assistant secretary, K. Ward Smith; auditor, H. Blair Smith.

CONCONULLY, WASH.—Newton Thomas is organizing a company to take over the lines and instruments of the Pacific States Telegraph and Telephone Company in Okanogan county. He plans to incorporate the company under the state laws as the Okanogan Telephone and Telegraph Company. The company will have a capital of $25,000, in shares of $1 each. Seventeen thousand shares have been subscribed by residents.

PORTLAND, ORE.—Half a million dollars will be expended in the city of Portland in improving equipment and bettering service by the Pacific States Telephone and Telegraph system within the coming year, and at least $800,000 will be spent in the Oregon division. Improvements contemplated in Portland will include the establishment of three new telephone exchanges for the East Side, embracing an outlay of at least $150,000.

UTICA, N. Y.—At an adjourned meeting of the Remsen & West Canada Creek Telephone Company held at the office of the company at Northwood, the following persons were elected directors for the ensuing year: George E. Prichard, George F. Squires, Timothy Dunn, William T. Finch, Charles C. Bullock, Grotus Rising and Peter Ward. A meeting of the directors was held after the stockholders' meeting adjourned, and the same officers that served in 1905 were reelected. The company declared a seven per cent annual dividend.

MASON CITY, IOWA—The People's Mutual Telephone Company, which operates toll lines and exchanges in Franklin and Cerro Gordo counties, has been sold to a new syndicate headed by Charles F. Johnson. Associated with Mr. Johnson are E. N. Egge, of Rockwell, and C. M. Felland, of Joyce, Iowa. Mr. Egge will be the new manager of the company, and the headquarters will be moved from Hampton to Sheffield. The towns connected by this system and maintaining exchanges are Chapin, Latimer, Coulter, Alexander, Sheffield, Rockwell and Thornton.

READING, PA.—At a meeting of the Pennsylvania Telephone Company, in Harrisburg, the following directors were elected: William H. Beck, Washington, D. C.; S. S. Blair, Tyrone, Pa.; Addison Candor, Williamsport, Pa.; Frederick P. Fish, Boston, Mass.; Charles A. Fondersmith, Lancaster, Pa.; John E. Fox, Harrisburg, Pa.; C. Jay French, Boston, Mass.; H. S. Huidekoper, Philadelphia, Pa.; Allen P. Perley, Williamsport, Pa.; A. R. Shellenberger, Harrisburg, Pa.; Richard O'Brien, Scranton, Pa. The directors then elected the following officers: A. R. Shellenberger, president; H. S. Huidekoper, vice-president; J. H. Crosman, Jr., secretary and auditor; W. C. Fink, treasurer; L. H. Kinnard, general manager. The report shows that 1905 was the most prosperous year in the history of the company. In the thirty-eight counties that are under the jurisdiction of the Harrisburg offices the report shows that at the end of 1904 there were 31,763 telephones in operation, and at the close of 1905 there were 37,843 in operation, showing an increase of 6,080.

ELECTRIC LIGHTING.

CENTERVILLE, IND.—At a meeting of Centerville citizens it was decided to build an electric light plant.

BENTON, PA.—The Electric Light Company has been granted a ten-year contract to supply lighting for Benton.

EDWARDSVILLE, ILL.—The Edwardsville electric light and power plant has passed under the control of the McKinley syndicate.

YONKERS, N. Y.—The Yonkers board of aldermen, by unanimous vote, has declared in favor of municipal ownership of the city's lighting plant.

LAFOLLETTE, TENN.—The Lafollette Waterworks, Electric Light and Telephone Company has let the contract for an electric plant at Lafollette.

WAUKEGAN, ILL.—The North Shore Electric Company, which supplies the territory between Waukegan and Glencoe and west to Libertyville, is planning to erect a power plant on the lake front, to cost $500,000.

MONROVIA, CAL.—The Edison Electric Company has announced a reduction in rates for electricity from fifteen cents per kilowatt-hour to twelve cents, giving Monrovia the same price that prevails in Pomona. The change will go into effect April 1.

WESTBORO, MASS.—At a special town meeting Melvin H. Walker, Richard F. Parker and John W. Slattery were appointed a committee to investigate and report as to the advisability of establishing a municipal lighting plant for Westboro.

RIO VISTA, CAL.—A franchise has been granted to the Rio Vista Electric Light and Power Company by the board of town trustees, which gives the company the right to operate and maintain an electric light and power plant in the town of Rio Vista.

HUNTINGDON, PA.—The Huntingdon Gas Company has signed a contract with the borough council to light the streets with 2,000-candle-power arc lights at the rate of $41.55 per light for six years, beginning July 1, 1906, at the completion of the present contract.

MOUNT VERNON, N. Y.—At the annual meeting of the Yonkers Electric Light and Power Company the following were elected directors for the ensuing year: Thomas E. Murray, N. E. Brady, L. B. Gawtry, J. W. Lieb, Jr., H. J. Hemmens, R. A. Carter and H. Sanderson.

HUTCHINSON, KAN.—Work has been started on the rebuilding of the electric light plant and in enlarging and remodeling the boiler room of the Hutchinson Water, Light and Gas Company. The buildings are to be enlarged, new machinery added, and improvements made that will cost $75,000.

MONTROSE, COL.—Control of the Montrose Electric Light and Power Company has been sold to the United States Light and Traction Company, of Denver, W. F. Iliff, president, and C. K. Durbin, vice-president. E. W. Kassler, of Denver, will retain an interest in the property, but retires from active control.

HAZLETON, PA.—A ten-year contract for lighting the streets of West Hazleton has been entered into by the council of that borough with the Hazleton Electric Light Company. Twenty-one enclosed arc lights have been provided for at a cost of $65 per light, which means a saving over the present price paid by the borough of $1,000.

ANDERSON, S. C.—The Savannah River Power Company has organized by the election of H. A. Orr, president; C. Elmer Smith, of York, Pa., vice-president; S. M. Orr, treasurer, and E. K. Chapman, secretary. The other directors are H. H. Watkins and J. E. Sirrine. This is the million-dollar company which will develop electric power on the Savannah river and bring it to Anderson.

VANCOUVER, BRITISH COLUMBIA—H. W. Goode, president and general manager of the Portland General Electric Company, has purchased the entire stock of the Vancouver Electric Light and Power Company. The price paid has not been announced, but it is reported to be in the neighborhood of $200,000. Eastern capitalists are said to be interested in the deal. The Vancouver plant was owned by a local company, having been bought from the city by that company four years ago. It has at present a capacity of about 10,000 lights, and Mr. Goode has announced that some $50,000 will be expended this year in improvements.

PHILADELPHIA, PA.—By the terms of a deal consummated in Philadelphia the Media Electric Light, Heat and Power Company, with all its property and contracts, passes from the hands of Robert W. Downing, who has been practically the sole owner, to W. Roger Fronefield, Esq., who has been treasurer of the company, and H. W. Rhodes, secretary-treasurer of the Media Title and Trust Company.

SAGINAW, MICH.—Ex-Governor Aaron T. Bliss has disposed of his interests in the Shoshone Power Development Company, an enterprise which he promoted. The company was organized to use the Shoshone falls to develop electric power. It has a capital stock of $600,000 and its purpose is to utilize at least six falls this year. The company also has a franchise in Salt Lake City. The distance is 172 miles.

SCRANTON, PA.—At a meeting of the stockholders of the Dunmore Electric Light Company the following officers were elected: president, A. L. Snowden; vice-president, George M. Hallstead; secretary and treasurer, E. M. Stack; directors, H. A. Knapp, P. D. Manley, A. L. Snowden, S. B. Ball, F. D. Feldman, John Carney, E. M. Stack and G. M. Hallstead. The stockholders of the Scranton Illuminating, Heat and Power Company have elected officers as follows: president, A. L. Snowden; vice-president, W. F. Hallstead; secretary and treasurer, E. M. Stack; directors, A. L. Snowden, W. F. Hallstead, T. G. Wolf, Franklin Howell, G. M. Hallstead, S. B. Ball and E. M. Stack.

GRAND RAPIDS, MICH.—At a meeting of the stockholders of the Grand Rapids Edison company the following were elected as directors for the ensuing year: Daniel McCool, McGeorge Bundy, Thomas F. Bechtel, Harvey J. Hollister, Clay H. Hollister, George C. Peirce, A. F. Walker, Gerhard Becker, H. N. Higginbotham, K. K. McLaren, E. R. Coffin. At the meeting of the directors officers were elected as follows: president, Daniel McCool; vice-president, McGeorge Bundy, secretary and treasurer, Thomas F. Bechtel; general superintendent, A. F. Walker. Owing to the constantly growing demand for electricity for lighting and power purposes it will be necessary to increase the present capacity of the plant within the next year.

HAZLETON, PA.—The Wyoming Valley Gas and Electric Light Company has plans for the lighting of Hazleton, Hazle township, West Hazleton and other towns in the county with electricity from a central station, which was recently opened at Plymouth. It is proposed to furnish light to the following places: Plymouth borough and township, Nanticoke, Kingston, Dorranceton, Edwardsville, Luzerne borough, Forty Fort, Sugar Notch, Warrior Run, West Hazleton, Hazleton city, Hazle township, Kingston township, Hanover township, Newport and Jackson townships. Pole lines are to be built to all of these places from Plymouth over the shortest possible routes. The officers and directors are: president, C. H. Geist, Philadelphia; secretary, C. W. Fox, Philadelphia; treasurer, Charles B. Kelsey, Grand Rapids, Mich.

OBITUARY NOTICE.

MR. WILLIAM ALFRED HOVEY, well known in journalistic and literary circles, died in Boston, Mass., on Sunday, February 18, aged sixty-four. Mr. Hovey became associated with the Sanitary Commission through a visit to the army of the Potomac, and continued with the commission until 1865, rising finally to the office of assistant secretary of that body. After the war Mr. Hovey took up the study of mining and became engineer and superintendent with the coal mines in Schuylkill county, Pa., remaining there for about three years. In 1868 he removed to Chelsea, Mass., where he conducted a weekly paper. In 1872 he became managing editor of the Boston *Commercial Bulletin*, and in 1875, on the death of D. N. Haskell, he succeeded to the editorship of the Boston *Transcript*. Mr. Hovey retired from the *Transcript* in 1881, and established the *Manufacturers' Gazette*, also editing the *Sunday Budget*. Later he became president of the Merchants' Electric Light and Power Company. In 1884 Mr. Hovey became associate editor of the ELECTRICAL REVIEW. On February 25, 1885, Mr. Hovey called to order the first convention of the National Electric Light Association, becoming its first secretary, and resigning in August, 1885. About this time he became associated with the American Bell Telephone Company, with which connection he remained until the time of his death.

ELECTRIC RAILWAYS.

DES MOINES, IOWA—The Newton & Northwestern Railway is projecting an extension of its main line from a point near Boone into Ames.

HATTIESBURG, MISS.—An interurban electric road is projected to run from Hattiesburg to Rawls Springs and Mammoth Springs, two summer resorts distant about six miles from Hattiesburg.

BURLINGTON, IOWA—The building of a standard-gauge electric road from Columbus Junction to Mount Pleasant *via* Winfield and ultimately to Burlington is being considered by capitalists of the three towns.

POTTSTOWN, PA.—The Ringing Rocks trolley line, together with two hundred acres of land, has been sold at a trustee's sale for $23,000 to Cyrus Q. Guldin, of Reading, and Thomas Searles, of Pottstown, two of the bondholders.

JACKSON, MICH.—The Michigan & Indiana Traction Company has been granted a franchise by the Three Rivers council to operate an electric line through the city. The proposed line will connect Elkhart and Kalamazoo *via* Constantine, Three Rivers and Vicksburg.

WESSON, MISS.—A move is on foot to connect with the Mississippi Central Railroad by an electric line either at Henck's Retreat, six miles from Wesson, or at Brookhaven, a distance of eight miles. The projectors are Messrs. L. L. Auding, C. E. Hartwell, S. P. Bloom and J. C. Pettigrew.

CANON CITY, COL.—At a meeting of the Canon City city council final action was taken granting F. S. Granger, of San Jose, Cal., a twenty-five-year franchise to construct a system of electric street railways, connecting Canon City and the suburbs with Florence, South Canon, East Canon and the top of the Royal gorge.

ANNISTON, ALA.—The Anniston Electric and Gas Company has accepted the franchise recently granted by the city council of Oxford for the building of an electric line to Hobson City, and the company will make immediate application to the authorities of Hobson City for a franchise to extend the line to Hobson park.

BEREA, OHIO—Farmers in Strongsville and Olmsted townships are interesting themselves in an electric railway project. It is proposed to run a line from Strongsville to Eaton, Columbia, West View, Olmsted falls, to Berea and connect with the Cleveland & Southwestern Traction Company's line, and also with the Grafton line of that company for Elyria.

JACKSON, TENN.—Chicago capitalists have closed a deal by which they become owners of the Jackson & Suburban street car line. They paid $65,000 for the stock and will take possession on March 1. It is understood that the new owners will expend $400,000, if necessary, in extending the lines in the city and to the mill town of Bemis. The company further proposes to furnish cheaper lights.

ST. ALBANS, VT.—The newly organized Rutland Railway, Power and Light Company, with a capital of $1,500,000, has elected the following officers: president, G. Tracy Rogers, of Binghamton, N. Y.; vice-president, Leo H. Wise, of New York city; secretary and treasurer, C. H. West, of Rutland. The directors are the officers named and James F. Powers, of Troy, N. Y., and George T. Chaffee, of Rutland.

TOLEDO, OHIO—At the annual meeting of the Toledo Railways and Light Company two vacancies in the board of directors were filled by the election of Charles W. Wason, of Cleveland, and W. L. McKenna, of New York. The remaining members of the board, including Albion E. Lang and L. E. Beilstein, of Toledo; Henry A. Everett and Edward W. Moore, of Cleveland, and Robert B. Van Cortland, of New York, were reelected.

MAY'S LANDING, N. J.—The Atlantic City & Suburban Trolley Company contemplates extending its line from Somer's Point to English creek, and thence along the Great Egg Harbor river road to May's Landing, on across to Egg Harbor City and through to Tuckerton, passing through many small hamlets. From Tuckerton the proposed line will be extended to West Creek and to Absecon, connecting with the present line.

ALBANY, N. Y.—The state board of railroad commissioners has approved the petition by the Union Traction Company for leave to change its name and to assume the corporate name "Batavia, Medina & Ontario Railway Company." The company proposes to construct a street surface railroad from Batavia, Genesee county, northerly through the village of Medina, Orleans county, to Olcott, Niagara county, on the shore of lake Ontario.

PERSONAL MENTION.

MR. C. I. T. GOULD has been elected president of the Baltimore Electric Power Company, vice Mr. David E. Evans, resigned. Mr. B. S. Josselyn was reelected vice-president; Mr. W. T. Spring, secretary, and Mr. I. R. Bonsal, treasurer.

MR. G. A. NESBIT has resigned his connection with the Charles A. Thompson Company to accept the New York office management of the Munder Electric Company, Springfield, Mass. This latter company manufactures incandescent lamps.

MR. C. H. JUDSON has been appointed general superintendent of the Seattle (Wash.) Independent Telephone Company. Mr. Judson has been constructing engineer and manager of the Council Bluffs (Iowa) Independent Telephone Company for the last year.

MR. D. RAYMOND, superintendent of the Pittston exchange, of the Pennsylvania Consolidated Telephone Company, has resigned his position. Mr. Raymond will engage in mercantile business in Allentown. Mr. J. Krieger, of West Pittston, succeeds Mr. Raymond.

MR. WILLIAM H. BLOOD, JR., president of the National Electric Light Association, spent several days in New York city last week in consultation with other officers of the association regarding the development of plans for the Atlantic City convention, which will be held from June 5 to 8.

MR. GEORGE A. FRENCH, formerly of the Southern New England Telephone Company, has been appointed superintendent of the Duluth Telephone Company, Duluth, Minn. Mr. French also becomes superintendent of the Mesaba Telephone Company. He relieves Mr. H. B. Willard, who goes to Minneapolis with the Northwestern Telephone Company.

MR. FREDERICK LININGTON, for the past few years manager of the Houston (Tex.) office of the Southwestern Telegraph and Telephone Company, has been promoted to the position of superintendent of construction, with jurisdiction in the state of Arkansas. His headquarters will be at Little Rock.

MR. WILLIAM C. OURSLER has resigned as general manager of the Frederick & Middletown Electric Railway, Frederick, Md. Mr. Oursler went to Frederick from Baltimore and was appointed general manager when the present owners of the road took charge last October. He has accepted a position with a steam railroad.

MR. A. M. FRAZEE, superintendent of motive power for the Newark & Granville Street Railway Company, Newark, Ohio, has resigned to accept a position with the Tucker-Anthony syndicate at Duluth, Minn. Mr. Frazee will superintend the construction of a large power-house at Cloquette, Minn., about twenty miles from Duluth.

MR. AND MRS. MARK M. MURTAUGH and Mr. Thomas Murtaugh have sailed from Brooklyn, N. Y., for Sao Paulo, Brazil, where the two men will engage in the construction of a power plant for the Sao Paulo Tramway and Lighting Company. Mark Murtaugh has a contract for the erection of a plant which will furnish the corporation with water power, and his brother goes to act as superintendent.

MR. CARL HERING, Philadelphia, Pa., who has long been prominently identified with the movement in this country to establish the metric system as a standard, was invited recently by Chairman Southard, of the house committee on coinage, weights and measures, which is considering the Littauer bill, to give his views concerning the proposed legislation for the employment of the metric system. Mr. Hering was unable to attend the hearing, but sent a brief communication to the committee outlining his views and very emphatically endorsing the adoption of the system, pointing out its advantages and showing the fallacy of some of the objections.

ELECTRICAL SECURITIES.

The departure of many prominent financiers and men of large capital interested in stock market activity has given emphasis to the conclusion that these interests have succeeded in unloading surplus securities, and that for some little time there will be more or less antipathy in the market. Commission house business has been dwindling very much of late and with the extensive liquidation that has been in force, with the consequent decline in prices, it is apparent that the speculating public has lost interest, to a considerable degree, in price movements. Notwithstanding this attitude of some of the most active speculators, it was announced in several quarters last week that some very high-class securities would soon be thrown upon the market, and that if this happened there would be found no shortage of money. The recent recovery of the money market proves the inherent stability of finances in general, and the very high rates which were charged for loans for a few days, with the announcements of very few business collapses, indicate the firm basis upon which business as a whole is resting. While it is generally felt that there will be no coal strike, this development has acted as a check upon the market and will probably continue to do so until the pending conference ends.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 17.

New York:	*Closing.*
Brooklyn Rapid Transit	79½
Consolidated Gas	175
General Electric	169¾
Interborough Rapid Transit	227½
Kings County Electric	200
Manhattan Elevated	158½
Metropolitan Street Railway	116½
New York & New Jersey Telephone	155
Westinghouse Manufacturing Company	185

The income account of the Interborough Rapid Transit system (both Manhattan and subway divisions) for the quarter and twelve months ended December 31, 1905, follows: October 1 to December 31 gross, $5,181,602; expenses, $2,137,354; net, $3,044,248; other income, $225,792; total income, $3,270,040; charges, $2,306,759; surplus, $963,281, as compared with $439,570 for the corresponding quarter of 1904. January 1 to December 31, 1905—gross, $18,218,264; expenses, $8,245,005; net, $9,973,259; other income, $701,661; total income, $10,674,920; charges, $8,170,780; surplus, $2,504,140.

The statement of the New York City Railway Company for the December 31 quarter is as follows: gross, $4,453,875; expenses, $2,471,462; net, $1,982,413; other income, $313,956; total, $2,296,369; charges, $2,812,000; deficit, $515,631, as compared with $540,944 for the same quarter of 1904.

It is officially announced that the shareholders of the Westinghouse Electric and Manufacturing Company have exercised their rights to subscribe to the new issue of bonds to the aggregate of $7,109,800, equivalent to 85 per cent of the amount available. The remainder, $7,890,200, purchased by Kuhn, Loeb & Company, therefore amounts to about one-eighth of the application for participation by the underwriting syndicate.

The income account of the New York & New Jersey Telephone Company for the year ended December 31, 1905, follows: gross, $6,217,288; expenses, $4,575,845; net, $1,641,443; charges and taxes, $195,428; surplus, $1,446,015; dividends, $1,034,149; surplus, $411,866, as compared with $514,863 for 1904. The reduction in rates in Brooklyn, Queens and Richmond, Jersey City, Newark and other places during the year rendered the surplus smaller proportionally than in previous years. The gain in stations during the year was 31,725, or nearly 40 per cent. The authorized capital stock of the company is now $17,360,000, an increase of 25 per cent during 1905. Expenditures for construction last year amounted to $3,027,000. The total number of stations on January 1 was 112,049.

The regular quarterly dividend of 2 per cent on Kings County Electric Light and Power stock is payable March 1.

Boston:	*Closing.*
American Telephone and Telegraph	142¼
Edison Electric Illuminating	246
Massachusetts Electric	67
New England Telephone	135
Western Telephone and Telegraph preferred	90

President F. P. Fish, of the American Telephone and Telegraph Company, states that the company has sold $100,000,000 4 per cent convertible bonds to a syndicate composed of J. P. Morgan & Company, Kuhn, Loeb & Company, New York; Kidder, Peabody & Company, Boston, and Baring Brothers & Company, Limited, London. These bonds are convertible into stock at the rate of 140 any time after three years and up to twelve. They will provide funds for the improvement and extension of the company's system, for financing the needs of its subsidiary companies and for its general corporate purposes.

Philadelphia:	*Closing.*
Electric Company of America	11⅞
Electric Storage Battery common	79½
Electric Storage Battery Preferred	79½
Philadelphia Electric	7⅞
Philadelphia Rapid Transit	31½
United Gas Improvement	98

It is reported that the Philadelphia Electric Company's surplus for 1905 over fixed charges amounts to about $800,000. The surplus earned in 1904 was $702,000.

The United Gas Improvement Company, of Philadelphia, will increase its capital stock by $9,181,250, making the total $45,906,250, the new stock being offered to stockholders at par.

Chicago:	*Closing.*
Chicago Telephone	130
Chicago Edison Light	165
Metropolitan Elevated preferred	70½
National Carbon common	86
National Carbon preferred	117
Union Traction Common	11
Union Traction preferred	44

The daily passenger receipts of the Chicago City Railway Company for 1905 were $19,837, an increase of $1,778. The number of passengers carried was 233,412,268, an increase of 11 per cent.

NEW INCORPORATIONS.

DES MOINES, IOWA—Indianola Interurban Railway Company. $50,000.

INDIANAPOLIS, IND.—Royse Electric Company. Increased from $15,000 to $25,000.

GLENWOOD, WIS.—West Wisconsin Telephone Company, Glenwood. Increased from $5,000 to $7,000.

MILWAUKEE, WIS.—Chicago & Milwaukee Electric Railway Company. $100,000. Incorporators: J. H. Marshutz, J. C. Stevens and Louis Quarles.

COLUMBUS, OHIO—The Noble County Telephone Company. $10,000. Incorporators: H. W. Kuntz, N. H. Bowman, J. S. Jones, W. J. Shively and L. W. Wheeler.

ST. PAUL, MINN.—Sedan Telephone Company, Sedan. $2,500. Incorporators: William Wolfe, Henry Hess, W. E. Martin, Sedan; A. Woodhall, M. C. Whitney, Grove Lake.

NEW LEXINGTON, OHIO—The Citizens' Independent Telephone Company. $50,000. Incorporators: J. B. Rhoades, T. J. Smith, C. H. Bell, J. W. Fry and J. G. Morris.

GUTHRIE, OKLA.—The Bidwell Electric Company, of El Reno and Chicago. $2,000,000. Incorporators: Benson Bidwell and G. W. Johnston, of Chicago; H. L. Fogg, of El Reno.

GUTHRIE, OKLA.—Navajo Telephone Company, of Headrick. To build a telephone line from Headrick to Warner. $1,000. Incorporators: W. J. Hastings, Jonathan F. Knox and Joe Ricks.

SALT LAKE CITY, UTAH—Mill Creek Power Company. To install a plant in Mill creek cañon. $300,000. Officers: Melvin M. Miller, president; David B. Brinton, vice-president; Francis M. Lyman, Jr., secretary; John P. Cahoon, treasurer.

ALBANY, N. Y.—The Hudson River & Eastern Traction Company, of Ossining. To operate an electric road nine miles long, from a connection with the New York Central Railroad in Ossining, through Briar Cliff Manor, Pleasantville and Sherman Park. $400,000. Directors: Ashley T. Cole, L. B. Grant, Arthur McCausland, Alexander Keogh, Peter C. Schutrum, Rudolph W. Yates, Joseph A. Byrne, Howard F. Keeler and George H. Sellers, of New York city.

INDUSTRIAL ITEMS.

THE INDIA RUBBER AND GUTTA PERCHA INSULATING COMPANY, Yonkers, N. Y., is distributing a neat calendar advertising Habershaw wires and cables.

THE PARDRIDGE SHADE AND REFLECTOR COMPANY, 183-185 Dearborn street, Chicago, Ill., announces that the company is for sale. It is also stated that the present monthly sales are sixty per cent of the price asked.

THE AMERICAN ELECTRIC LAMP COMPANY announces the removal of its factory from York, Pa., to Philadelphia, Pa. The new factory has a capacity of 25,000 lamps per day. The New York office of this company is continued at 26 Cortlandt street.

THE R. E. HARDY COMPANY, 225 West Broadway, New York city, has published an illustrated booklet descriptive of "Sta-Rite" ignition plugs, spark coils, etc. This company's line of ignition plugs consists of six distinct types and forty-seven sizes.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., in pamphlet No. 061 gives an introduction to its general line of machinery. This covers hoisting and elevating apparatus of various descriptions, and automatic and industrial railways.

THE WORCESTER ELECTRIC MANUFACTURING COMPANY, 42 Lagrange Street, Worcester, Mass., will be pleased to send its bulletin descriptive of switchboard and panelboard apparatus. The company has recently published some data concerning standard switchboards and switchboard parts.

V. C. GILPIN, 120 Liberty street, New York city, has accepted the New York agency of the Scranton Button Company, Scranton, Pa., manufacturers of composition-moulded material which is suitable for all purposes where hard rubber or fibre might be used, especially telephone mouthpieces, receivers, switch handles, socket keys and bushings.

THE E. H. FREEMAN ELECTRIC COMPANY, 100 Hamilton avenue, Trenton, N. J., is placing on the market a bracket or fixture weatherproof socket with removable cap. The cap is heavy stamped brass with extra strong bushing, and is polished and lacquered. These sockets are fitted with rubber-covered wires nine inches long. Longer wires may be fitted upon order.

THE DIEHL MANUFACTURING COMPANY has recently leased the entire building at 1305 Race street, Philadelphia, Pa., for use as a warehouse, and a much more complete stock of apparatus of all kinds will be carried. The large increase of the business of the Philadelphia office of the company has made this action necessary. The office still remains at 1217 Filbert street.

THE LAFAYETTE ELECTRICAL MANUFACTURING COMPANY, Lafayette, Ind., in bulletin D describes the Hornberger transformer. This transformer is the invention of Mr. William H. Hornberger, electrical engineer and general manager of the company. The Hornberger transformer is of the core construction, oil-cooled type, made in capacities from 500 watts to 50,000 watts.

THE ELECTRIC CABLE COMPANY, New York city, has secured an order from the Interborough Rapid Transit Company for fifteen miles of cables insulated with "Voltax." The company announces that recent tests made by the Electrical Testing Laboratories, New York city, show that this material can withstand very high voltages, and that its insulation, resistance and melting points are decidedly favorable.

DOSSERT & COMPANY, New York city, announce their removal to their new factory and offices at 242 West Forty-first street, where they will have quarters more suitable to their increasing business. They are making radical changes and installing a number of improvements in their manufacturing system. This will largely increase the production and improve the quality of the goods, also enabling more prompt deliveries.

THE SPRAGUE ELECTRIC COMPANY, New York city, has recently sold sixteen motors to Edwards, Deutsch & Heitmann, Chicago, Ill., for driving printing presses and allied machines. Among other well-known firms which have placed orders with the Sprague company are Styles & Cash, New York city, thirty-seven motors; G. Schirmer, New York city, twenty-five motors; and Perley & Company, Pittsburg, Pa., twenty-two motors.

THE ALLIS-CHALMERS COMPANY, Milwaukee, Wis., has secured a contract to install six 5,200-horse-power twin hydraulic turbines at a new power station near Fort Lawn, S. C., for the Southern Power Company, of Charlotte, N. C. In addition there will also be installed two 700-horse-power twin horizontal exciter turbines. The Allis-Chalmers Company has recently contracted with the California Gas and Electric Corporation, San Francisco, Cal., for a 9,700-horse-power, single horizontal, spiral case reaction hydraulic turbine. The turbine will operate under a head of 550 feet at a speed of 400 revolutions per minute.

THE TRIUMPH ELECTRIC COMPANY, Cincinnati, Ohio, has appointed the Hallidie Machinery Company, Seattle, Wash., its agent on the northwest Pacific coast. This will mean a large increase in the use of Triumph apparatus in that region. The company is continuing its record on factory plant installations. Among those recently completed are a 150-kilowatt belted generator, switchboard and motors for the John Van Range Company; a 150-kilowatt direct-connected generator, switchboard and motors for Helmers, Bettmann & Company, shoe manufacturers; a 200-kilowatt generator, switchboard and motors for the Yellow Poplar Lumber Company; a generator and motors for the O. R. Armleder Company, carriage manufacturers; fifty motors for the A. H. Pugh Printing Company; twenty-five motors for the United States Printing Company, to whom the Triumph company had previously sold a generator and a number of motors.

THE CHICAGO PNEUMATIC TOOL COMPANY, Chicago, Ill., announces the fourth annual report of the president to the shareholders. The surplus on December 31, 1904, was $221,157.76. The surplus for 1905 was $315,134.39, making the surplus carried forward $536,292.15. The dividends, aggregating four per cent per annum, were $244,551.32. During the year the company acquired the business of the Philadelphia Pneumatic Tool Company. The company has also acquired the business and plant of the Canadian Pneumatic Tool Company, Limited, Montreal, Canada. During the past year the Consolidated Pneumatic Tool Company, Limited, of London, has been developing the organization of the Fraserburgh plant, Scotland, and extending its operations until at the present time it is running to full capacity. The foreign operations have been further enlarged during the past year by the organization of the International Compressed Air and Electric Company, Berlin, which company acquired the business of Isaac G. Eckstein, and is now conducting continental operations.

NEW PUBLICATION.

BUREAU OF STANDARDS—The annual report of the director of the Bureau of Standards to the secretary of the Department of Commerce and Labor for the fiscal year ended June 30, 1905, has been issued. This details briefly the work done on the bureau's buildings and the work of the bureau itself.

NEW MANUFACTURING AND CONSTRUCTING COMPANIES.

PHILADELPHIA, PA.—The Cleverly Electrical Works, Incorporated, has been organized with a capital of $10,000.

JERSEY CITY, N. J.—The Railway Electric Signal Company, with a capital stock of $50,000, has been incorporated by George Laude, Jr., L. B. Elkins, Jr., and Edward P. Coyne.

NEW YORK, N. Y.—The Constantine Storage Battery Company has been incorporated with a capital of $8,000, and the following directors: E. B. Constantine, Brooklyn; W. H. Smith, J. A. MacEwan, Passaic, N. J.

JERSEY CITY, N. J.—The American Electrical Novelty Manufacturing Company of the Pacific Coast has been incorporated with a capital of $30,000. The incorporators are H. O. Coughlan, J. R. Turner, B. S. Mantz, Jersey City.

NEW YORK, N. Y.—The F. P. Harrison Electric and Manufacturing Company has been organized to engage in a contracting business. The capital stock is $5,000, and the incorporators are F. P. Harrison, New York; W. H. Harrison, A. J. Harrison, Brooklyn.